THE GLASS INDUSTRY

VOLUME 30, NUMBER 11, NOVEMBER, 1949

PROPOSED DURABILITY TESTS FOR GLASS AND GLASS CONTAINERS

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The Glass Containers Advisory Committee of the U. S. Pharmacopoeia has the same membership as Subcommittee VII A, Pharmaceutical Containers, of Committee C14 Glass and Glass Products, of the American Society for Testing Materials. This happy arrangement has made it possible to coordinate the work of these two committees in the development of standard methods for testing the durability of glass and glass containers.

There have been, in the course of time, innumerable tests devised for the purpose of measuring the durability of a glass or of a glass container without waiting for the time that must necessarily elapse before observing an indicated period of actual service. Unquestionably the best way to determine the attack of a given solution on a given glass is to package the solution in containers of the glass and then after regular processing and storage to observe changes in color, reaction, potency, toxicity, etc. Such tests take a long time and it is often difficult to actually evaluate the effect of a glass container upon a particular solution.

If one is already in possession of service data on a given glass indicating that the glass has given satisfactory service with a certain solution, it is convenient to have some method of testing which will insure that subsequent shipments are the same as those shipments which have yielded satisfactory service. In the case where service data is lacking, there is a definite field of usefulness for tests which will yield some information as to the probable suitability of the glass in question.

Since 1926, the official pharmaceutical compendia, National Formulary and U. S. Pharmacopoeia, have carried various tests for indicating the suitability of glasses for packaging drugs intended for injection. In the last editions of the two compendia, U.S.P. XIII and N.F. VIII, there are 4 different tests indicated for examining into the quality of different types of glasses.

Since alkaline ions are probably the most frequent cause of drug deterioration, the usual scheme of the test is to determine the amount of alkali liberated under conditions which simulate sterilization or storage. In the case of the Type IV tests of the pharmaceutical compendia use has been made of the total solids extracted from the glass container when autoclaved at 121°C.

In September, 1943, a subcommittee of Committee C14, A.S.T.M. which had been considering methods of test for glass and glass containers reported a set of 6 methods. There was thus a total of 10 glass tests with some official standing available for consideration by the pharmaceutical and glass industries. In April, 1944, a project was undertaken by Subcommittee VII A, Pharmaceutical Containers, to simplify the scheme of testing. Much study was given to the various tests in order to improve their convenience and precision. The tests were separated into elements as follows:

Item tested:	Bottle or powder
Temperature of test:	90° C. or 121° C.
Attacking liquid:	Water or acid
Assay method:	Titration of alkali, or determination of solids in extract

A set of procedures was constructed from the original 10 procedures and designations applied as follows:

B90W	B90A	B121W	B121A
P90W	P90A	P121W	P121A

In the designations of these procedures, B refers to a bottle (whole container) test and P to a test on powdered glass. The number refers to the temperature at which the test is run. The letter W indicates that water is the attacking liquid, and A indicates that the attacking liquid is acid.

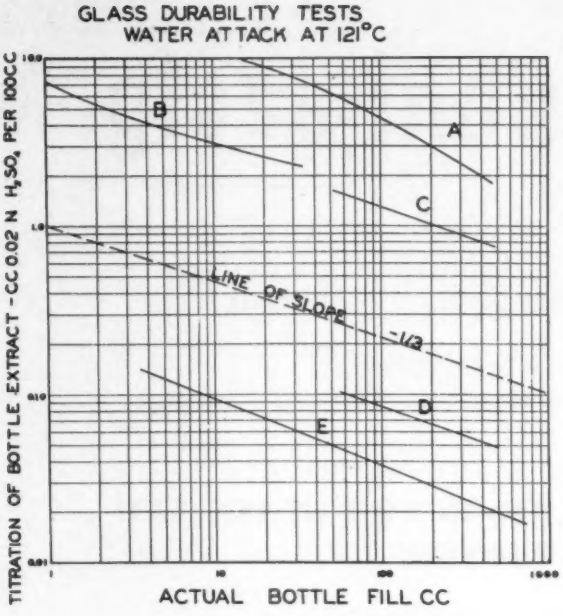

FIG. 1

A cooperative project was set up whereby four bottle manufacturers supplied 2-ounce bottles and 16-ounce bottles for test by the proposed methods. The glasses involved were as follows:

A—Borosilicate
B—Surface treated lime glass
C—Borosilicate
D—Lime bottle glass

The following laboratories volunteered to conduct tests on these four glasses: National Bureau of Standards; American Pharmaceutical Association; Mellon Institute, for USP; Hazel-Atlas Glass Company; Armstrong Cork Company; Owens-Illinois General Research Laboratory; T. C. Wheaton Company; Kimble Division, Owens-Illinois Glass Company.

In the operation of this project it became apparent that to secure a reasonable precision in performing such durability tests, it is necessary to have clean quarters free from dust and fumes, skilled operators, adequate equipment and close adherence to a number of minute details. The committee tested 3 sets of cooperative samples, held a large number of meetings to discuss and consider the various points which came to light and devoted considerable time to experimental work and working out various details of the tests. This work is reported in considerable detail in the *Bulletin of the National Formulary Committee,* Vol. XVII, Nos. 3-4, March-April 1949 (The American Pharmaceutical Association, Washington, D. C.). Some of the points developed during these cooperative tests are listed briefly below.

General. 1. Good control of temperature and heating schedules is necessary to insure reproducible results. 2. For titrations of less than 1 cc, a semi-micro burette with a fine tip and yielding drops of 0.01cc should be used. 3. Solutions of methyl red indicator should be neutral so that a titration blank does not exceed 0.02 cc of 0.020 N sodium hydroxide. 4. Where water is the attacking liquid, it was found satisfactory to use water whose carbon dioxide content is in equilibrium with atmospheric carbon dioxide. This eliminates the necessity for boiling the water before use. 5. The practice of calculating the alkali extracted to percentages or to terms of milligrams sodium hydroxide was dispensed with. Instead, the alkali extracted was reported directly as the difference in titration between the attacking liquid before the test period and the attacking liquid after the test period. The object of this was to eliminate some uncertainty in the final figure which resulted when the original figure was multiplied by a factor. 6. After the test period at 121°C, the autoclave should be cooled at the rate of 0.5°C per minute instead of at more rapid rates previously employed. This is to decrease mechanical loss of liquid due to ebullition at the time the pressure of the autoclave is released.

Powder Test. 1. For each 10 gram sample of glass grains, a separate 100 gram portion of glass is to be crushed and sieved. This is to prevent the overloading of screens which takes place if two and three determinations are prepared at one time and a large amount of crushed glass put on the screen. 2. The sieved glass grains are to be washed with dry acetone to remove the fine powder which adheres to the grains. Failure to remove this fine powder causes a high result in the test and washing it off with water causes a low result because it extracts some alkali from the glass grains.

Bottle Test. 1. Since water expands when heated from room temperature to the test temperature, bottles for testing at 121°C are filled to 90% of overflow capacity. This prevents overflowing when the water heats up in the autoclave. 2. In B121W no correction is made for the temperature of the hot extract when 100 cc is measured for titration. This causes a slight negative error which is offset by a slight positive error caused by concentration of the extract when the pressure in the autoclave is released. 3. The determination of total solids extracted from the glass was eliminated because the test was found difficult to perform and lacked precision. In commercial containers there is some relation between the total solids extracted and the alkali available for titration. 4. In B121A it was agreed to use 0.0002 N acid as attacking liquid instead of stronger solutions proposed earlier. However, if the bottles to be tested will neutralize more than 0.80 cc of 0.020 normal acid per 100 cc of test acid, 0.0005 N test acid is to be used.

In the B121A test it has been found that evaporation of water and loss of acid takes place when the pressure in the autoclave is released. At that time and until the pressure in the autoclave drops to atmospheric level the temperature of the acid solution exceeds its boiling point. Because of this evaporation of water, when bottles of very good resistance are tested, it is sometimes found that the concentration of the acid in the bottle is higher after the test period than before. In the case of round pharmaceutical containers of size over 15 cc, it was found that the apparent concentration amounted to 2%. Therefore it is advisable to multiply the final titration by 0.98 in order to correct it for the increase of acid strength which takes place at the time of releasing the autoclave pressure.

After studying the various possible methods of testing glass and glass containers enumerated above, the committee agreed to recommend the use of the following 3 tests, by U. S. Pharmacopoeia and National Formulary for containers for injections: B121W for bottles intended

for solutions of pH 5.0 or greater; B121A for bottles intended for solutions of pH less than 5.0; P121W for very small containers, which are extremely tedious to test by the bottle test, and for items like vaccine tubes and syringe cartridges which are difficult to test by surface tests.

It will be observed that all 3 tests are performed at 121°C which is a much used temperature for sterilization in the pharmaceutical industry, corresponding to an autoclave pressure of 15 psi. This temperature was selected rather than the alternative proposal of 90°C because the testing of glass containers at 90°C would make it necessary for pharmaceutical houses to procure special baths for this test procedure. They already have autoclaves. Also, in order to produce a uniform temperature in a bottle being tested at 90°C, it is necessary to immerse the bottle almost to its top in the bath. Since the bath must be well stirred to secure good temperature control, it is difficult to prevent some of the bath liquid from getting into the bottles under test. Durability tests performed in autoclaves require much less time than tests performed at 90°C.

On the basis of the above studies and findings, the U.S.P. Glass Containers Advisory Committee has recommended detailed procedures for the tests B121W, B121A and P121W. These procedures are given in full by Melvin W. Green in *Bulletin of the National Formulary Committee*, Vol. XVII, Numbers 3-4, March-April, 1949, The American Pharmaceutical Association, Washington, D. C. This article is reprinted in full in this issue of THE GLASS INDUSTRY.

The same procedures, with a slightly different wording were reported by Mr. F. C. Flint, Chairman of Subcommittee VII A (Pharmaceutical Containers) to Committee C14, Glass and Glass Products, A.S.T.M., and have been approved by Committee C14, A.S.T.M. for submission as tentative standards.

Table I

Test	Size	Ware	Mean	σ	V %	V' %
P-121-W		A	0.33	0.071	21	8
		B	6.49	0.867	13	3
		C	0.57	0.118	21	2
		D	6.19	0.570	9	5
B-121-A	2 oz.	A	0.08	0.046	58	14
		B	0.06	0.029	48	14
		C	0.21	0.031	15	0
		D	0.49	0.095	19	4
	16 oz.	A	0.03	0.016	53	14
		B	0.02	0.014	70	0
		C	0.13	0.035	27	0
		D	0.35	0.067	20	2
B-121-W	2 oz.	A	0.04	0.014	35	0
		B	0.06	0.014	23	0
		C	0.10	0.035	35	0
		D	1.38	0.244	18	2
	16 oz.	A	0.02	0.012	60	20
		B	0.03	0.019	64	20
		C	0.05	0.016	32	0
		D	0.66	0.174	26	3

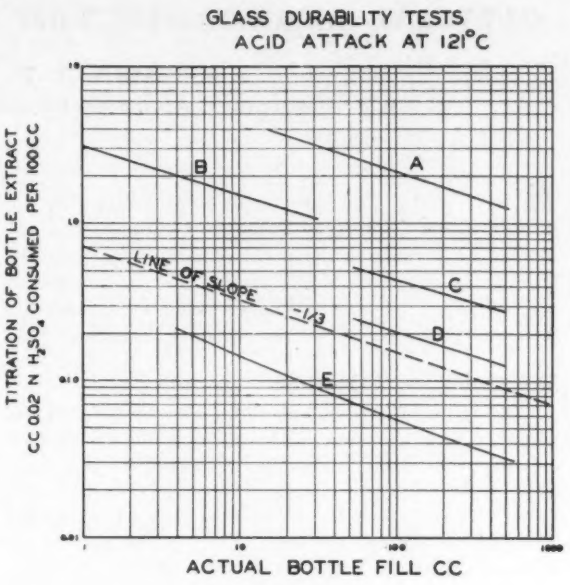

FIG. 2

The results for the final test series were analyzed[1] and the results of this analysis are shown in the first 6 columns of Table I. In this table are shown the standard deviation and coefficient of variation considering all determinations of all laboratories for each lot run. In the last column of Table I is given the coefficient of variation calculated[2] from the determination of two laboratories with considerable experience in this type of work, who worked independently of each other. We therefore believe that better agreement will be reached by different laboratories after the tests have been in general use for some time.

In considering the figures for attack obtained by tests on bottles of the same glass but of different sizes, it is evident that larger figures for attack are secured from the smaller containers. This is because the ratio of area to volume of the containers varies inversely as the cube root of the volume. It is therefore a convenience to plot the figures obtained by titration of bottle extracts against the actual bottle capacities on log-log paper. Because of the cube root relation, such a graph should be a straight line of slope minus ⅓ provided the attacking liquid and the nature of the attack does not change in the course of the test, and from bottle to bottle. Figure 1 shows such a plot for water attack at 121°C and Figure 2 shows such a plot for acid attack at 121°C. It will be observed that the slopes of the graphs obtained from actual data approach quite close to the theoretical slope of minus ⅓. In fact, if some approximation is desired for the test which would be obtained on a bottle of a certain size, and the test is available for the same glass in a bottle of different size, the single point can be plotted on log-log paper and a line of slope minus ⅓ drawn through it. A useful approximation to the test for other size bottles can then be read off the graph.

Acknowledgments

The discussions involved in developing the durability

(*Continued on page* 638)

OFFICIAL STANDARDS FOR CONTAINERS FOR INJECTION

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Based on the preceding reports of studies by the U. S. P. Glass Containers Advisory Committee, the following is a revision of the official standards for glass containers for injections. This revised text is intended to replace pages 630-633 of United States Pharmacopoeia XIII and pages 699-702 of the National Formulary VIII.

Containers for Injections

Containers for injections shall be so constructed and packaged that the quality and sterility of the contents are not impaired. As it is important to examine the appearance of the contents, containers for injections are composed of clear glass, not clouded or colored, unless the contents are affected by light. Even in the case of the latter, enclosing the container or containers of clear glass in closed cartons, impervious to light, will protect the contents. The immediate container must be sterile before being filled unless the container and contents are subsequently to be sterilized by Process C or other suitable effective process.

The container must be sealed or otherwise protected so as to exclude organisms. A container of multiple doses, designed to permit the withdrawal of successive volumes on different occasions, must be closed with a suitable rubber cap or other suitable closure.

The testing procedures which follow have been designed to determine the resistance of various types of glass to acid or alkaline attack. The degree of attack is determined by the amount of alkali released from the glass under the influence of the attacking medium under the conditions specified. This quantity of alkali is extremely small and in case of the more resistant glasses approaches microquantities, thus calling for particular care in attention to all details of the test. All equipment used in these tests should be of high quality and precision and the tests should be carried out in a laboratory relatively free from fumes and excessive dust.

Apparatus and Reagents for Glass Testing

Autoclave. For these tests use an autoclave capable of withstanding a pressure of 24 lbs. per square inch and suitably arranged to maintain a temperature of 121 ± 0.5°. During testing procedures, the temperature must be checked periodically with a suitably calibrated instrument. The autoclave should be equipped with a thermometer, a pressure gage and a vent cock, and should have an adequate capacity for the accommodation of at least 12 of the test containers. There should also be a rack in the autoclave for supporting the samples above the water level.

Mortar. A specially designed steel mortar[1] made according to the specifications of the accompanying figure is required. (Fig. 1.)

Other Equipment. Other pieces of apparatus required are a nest of 8-inch sieves including the No. 20, No. 40 and No. 50 sieve along with the pan and cover, 250-cc. Erlenmeyer flasks made of resistant glass aged as specified, a hammer weighing about 3 lbs., a permanent magnet, a desiccator, tin foil, and adequate volumetric apparatus and other pieces of apparatus usually found in a laboratory.

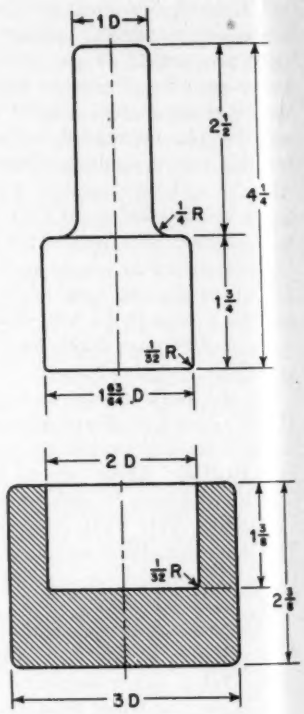


Fig. 1. Special mortar for pulverizing glass.

Special Distilled Water. The water to be used in these tests is distilled water, re-distilled from an all-glass still constructed of chemically resistant glass and equipped with ground glass joints. In operating the still, add one drop of phosphoric acid to each liter of water contained in the still. Reject the first 10 or 15 per cent of the distillate and retain the next 75 per cent. The distillate must have a specific conductivity of 2×10^{-6} ohms or less at 20° and it must be free from dissolved gases and heavy metals, particularly copper.

0.02 N Sodium Hydroxide. Prepare carbonate-free 0.02 *N* Sodium Hydroxide in the usual manner and standardize it against potassium acid phthallate using phenolphthalein T. S. as the indicator. Adjust, if necessary, to 0.02 *N* ± 2.5 per cent.

0.02 N Sulfuric Acid. Prepare 0.02 *N* sulfuric acid in the usual manner and standardize against the 0.02 *N* Sodium Hydroxide using methyl red T. S. as the indicator. Adjust, if necessary, to 0.02 N ± 2.5 per cent.

0.0002 N Sulfuric Acid. Dilute 0.1 *N* Sulfuric Acid to 0.0002 *N*, determine the normality and adjust to 0.0002 *N* ± 5 per cent.

0.0005 N Sulfuric Acid. Dilute 0.1 *N* Sulfuric Acid to 0.0005 *N*, determine the normality and adjust to 0.0005 *N* ± 5 per cent.

Methyl Red Solution for Testing Glass. Dissolve 200 mg. of methyl red in 60 cc. of alcohol, then add sufficient distilled water to make 100 cc. If necessary, neutralize the solution with 0.02 *N* Sodium Hydroxide so that the titration of 100 cc. of the special distilled water, containing 5 drops of indicator, does not require more than 0.02 cc. or 0.02 *N* Sodium Hydroxide to effect the color change of the indicator.

Reprinted from the *Bulletin of the National Formulary Committee*, The American Pharmaceutical Association, March—April 1949.

[1] This mortar and pestle can be obtained from Precision Scientific Co., Chicago 47, Ill.

Powdered Glass Test

Take a sufficient number of containers at random, not less than 6, rinse them thoroughly with distilled water and dry with a stream of clean air. Crush the containers to about 25-mm. size using about 100 Gm. for the test and place about 40 Gm. at a time of the coarsely crushed sample in the special steel mortar. Insert the pestle and strike it with 3 or 4 hammer blows. Empty the contents of the mortar into a No. 20 sieve which is nested in a No. 40 sieve which in turn is nested in a No. 50 sieve. Repeat the crushing operation until the entire 100 Gm. of glass has been added to the nest of sieves. Shake the sieves for a short time, then remove the glass from the No. 20 and No. 40 sieves and recrush and sieve as before. Repeat this recrushing and sieving operation for the third time. Empty the receiving pan, reassemble the nest of sieves and shake on a mechanical sieve shaker for 5 minutes or by hand for an equivalent length of time. Reserve for test the glass grains that pass the No. 40 sieve and are retained on the No. 50 sieve. Keep the sample, which should be in excess of 10 Gm., in a desiccator in a closed sample bottle until used.

Spread the sample on a piece of glazed paper and pass a magnet through it to remove particles of iron which may have been introduced during the crushing. Transfer the sample to a 250-cc. Erlenmeyer flask of resistant glass and wash the sample with 6 successive 30-cc. portions of reagent acetone, swirling each time for about 30 seconds and carefully decanting the acetone. At this point the sample should be free from agglomerations of glass powder and the surface of the grains should be practically free from adhering fine particles. Dry the flask and contents at 140° for 20 minutes, transfer the grains to a weighing bottle, close, and cool in a desiccator over calcium chloride. The sample must be used for the test within 48 hours after drying.

Procedure. Transfer exactly 10 Gm. of the prepared sample to a 250-cc. Erlenmeyer flask that has been digested (aged) previously with special distilled water for at least 24 hours in a bath at 90° or for 1 hour at 121°. Add exactly 50 cc. of the special distilled water. Prepare a blank by adding 50 cc. of the special distilled water to a similarly prepared flask and cap all flasks with crimped new tin foil that has been rinsed with 2 portions of acetone. Adjust, if necessary, the sample rack in the autoclave so that the samples are above the water level. Place the containers on the rack in the autoclave and close the cover securely, leaving the vent cock open. Heat until steam issues vigorously from the vent cock and continue heating for 10 minutes. Close the vent cock and adjust the temperature so that it rises 1° per minute until it reaches 121° taking 19 to 23 minutes to reach the desired temperature. Hold the temperature at 121° ± 0.5° for 30 minutes, counting from the time when the final temperature is reached. At the end of the test period decrease the supply of heat and cool at the rate of 0.5° per minute to atmospheric pressure, venting to prevent the formation of a vacuum. The time to cool from 121° to atmospheric pressure should be from 38 to 46 minutes. Cool the flask in running water, add 5 drops of the methyl red solution for glass testing and titrate immediately with 0.02 *N* sulfuric acid. If the volume of titrating solution is less than 10 cc. use a microburette. Record the number of cc. of 0.02 *N* sulfuric acid used to neutralize the extract from 10 Gm. of glass less a blank on the empty flask.

Water Attack At 121°

Preparation of Sample. Select a sufficient number of containers, not less than 3, at random, and rinse each container with 2 portions of the special distilled water.

Procedure. Fill each container to 90 per cent of its overflow capacity with special distilled water, and cover with crimped pieces of new tin foil rinsed with 2 portions of acetone. Continue the test as in the *powdered glass test* beginning with "Adjust, if necessary, the sample rack . . ." except that the time of autoclaving shall be 1 hour instead of 30 minutes and ending with "The time to cool from 121° to atmospheric pressure should be from 38 to 46 minutes." Using a graduated cylinder, transfer 100 cc. of the water from each container, or, in the case of smaller containers, combined groups of containers, into a 250-cc. Erlenmeyer flask of resistant glass, add 5 drops of the methyl red solution for glass testing and titrate, while warm, with 0.02 *N* sulfuric acid. The time elapsing between opening the autoclave and titrating should not exceed 60 minutes. Report the results as cc. of 0.02 *N* sulfuric acid used less a blank obtained by titrating 100 cc. of the special distilled water at the same temperature and with the same amount of indicator.

Acid Attack At 121°

Preparation of Sample. Select a sufficient number of containers, not less than 3, at random, and rinse each container with 2 portions of the special distilled water. Follow with 2 similar rinsings with reagent acetone and dry with a stream of clean, dry air.

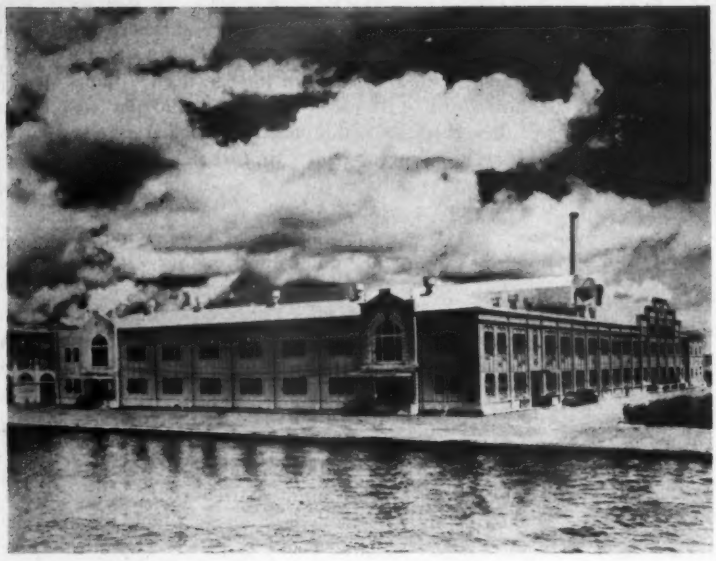
Procedure. Fill the containers to 90 per cent of overflow capacity with the attacking medium and cover with crimped pieces of new tin foil rinsed with 2 portions of acetone. If the bottle to be tested will neutralize more than the equivalent of 0.80 cc. of 0.02 *N* sulfuric acid per 100 cc. of contents, use 0.0005 *N* sulfuric acid as the attacking medium, otherwise use 0.0002 *N* sulfuric acid. Continue the test as described under the *powdered glass test* beginning with "Adjust, if necessary, the sample rack . . .", except that the time of autoclaving shall be 1 hour instead of 30 minutes, and ending with "The time to cool from 121° to atmospheric pressure should be from 38 to 46 minutes." Remove the containers from the autoclave and cool to room temperature. Transfer exactly 100 cc. of the acid from each container or, in the case of smaller containers, combined groups of containers, into a 250-cc. Erlenmeyer flask of resistant glass. Add 5 drops of methyl red solution for glass testing and titrate with 0.02 *N* sodium hydroxide. Record the results of the titration as cc. of 0.02 *N* acid consumed in the test by the use of the following formula:

cc. of 0.02 *N* acid consumed = V—0.98B in which V = cc. of 0.02 *N* sodium hydroxide equivalent to 100 cc. of the attacking medium and B = cc. of 0.02 *N* sodium hydroxide used in the titration of 100 cc. of bottle extract. The factor of 0.98 is applied to the titration of the bottle extract to correct for the loss of attacking medium during cooling of the autoclave.

Types of Containers

Containers for injections (ampuls) and other U.S.P. (N.F.) preparations for parenteral use, other than in oily vehicles, shall be one of the following types:

(*Continued on page* 636)



MODERNITY DISTINGUISHES THE SAN MIGUEL CONTAINER PLANT

By ARTHUR W. SCHMID, President
Arthur W. Schmid Company, Pittsburgh 22, Pa.

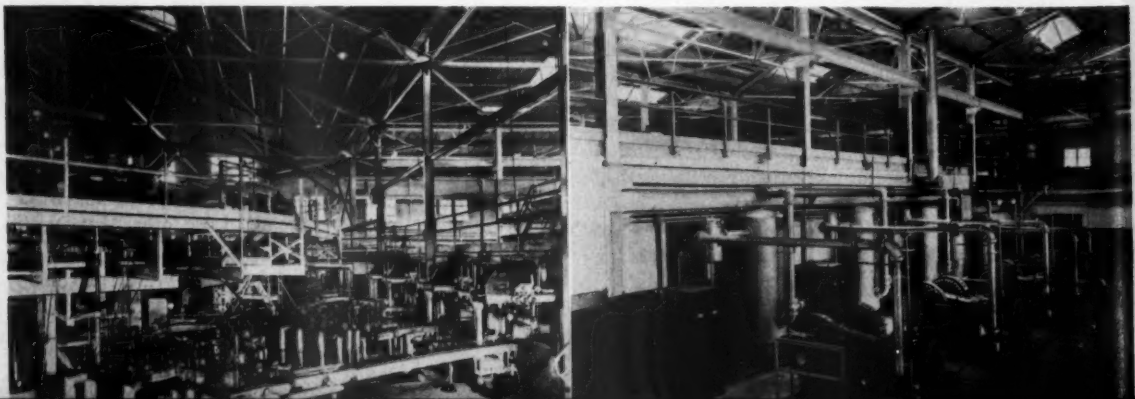
In 1936, Mr. Andrés Soriano, President, and the other directors of the San Miguel Brewery, Manila, Philippine Islands, began to think about making their own bottles for beer, beverages and milk, which are among the products produced by their company, and conferred with the author who was in the Orient at that time.

The erection of a small glass factory was started in 1937 and included were single mold suction machines and a small furnace. Before many months had passed, the capacity of the plant proved to be inadequate and a Lynch automatic machine with automatic gob feeder was installed. Other automatic equipment was on order when the war started in 1941, and during the Japanese occupation the factory was operated intermittently. After receiving some damage, it was finally completely destroyed during the liberation.

In November 1946, a little over a year after the end of the war, San Miguel representatives came to the United States and immediately began negotiations for the building of a new ultramodern factory for the manufacture of glass containers. The contract for the complete engineering was consummated shortly thereafter with the Arthur W. Schmid Company, Pittsburgh, Pennsylvania, and work on the engineering was started immediately. Although the complete plant was engineered by the latter company, it was adapted to local conditions with the help of Filipino engineers. The plant was erected and put in operation exclusively by Filipino engineers, and under the direction of Mr. Alfredo Villa-Abrille. Much credit must be given these engineers for their efforts in both the erection and operation which was successfully started shortly after the new factory was completed in April of this year.

Both the main building, built strictly along factory lines but still retaining the traditional San Miguel motif, as well as the batch house behind the main building, are constructed entirely of steel and concrete. All construc-

(Left) A view of the melting and forming end of the factory showing the furnace, feeders, machines, conveyors and lehr loaders. (Right) The compressor room.



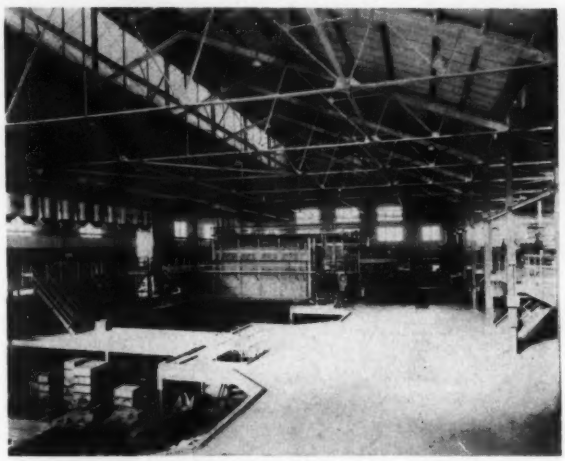
tion work was done by local building contractors. The total floor space area is approximately 200,000 sq. ft. and the cost of the plant exclusive of the property was $2,526,000.

One furnace with four Lynch "10" Machines is at present in operation, the second furnace is now under construction, and provision has been made for a third furnace. The daily pull is approximately 80 tons and the furnace is oil fired and completely equipped with all automatic controls.

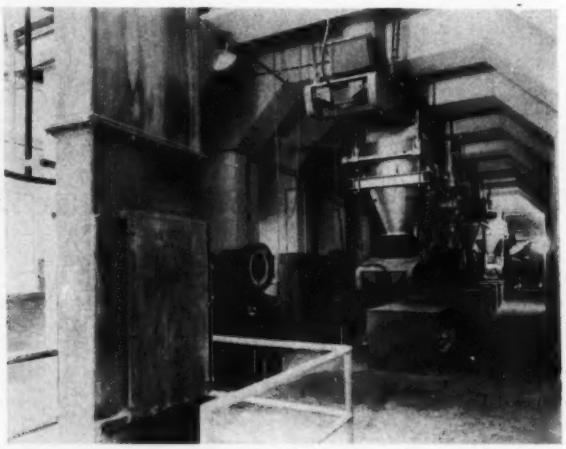
As many of the raw materials are received at the plant unprocessed, it was necessary to install equipment to completely process these materials before they could be used for the mixing of the batch. The building housing this processing equipment, storage bins and batch mixing equipment has a floor space area of 14,500 square feet and is located directly in back of the main building. The four main concrete silos are 18′ in diameter and extend 61′ above the ground level. They have a total storage capacity of 951 tons. The concrete tops are provided with plastic waterproof seals at the walls of the bins so that these tops may be easily raised in the future, and provision has been made for extending the walls to increase the storage capacity of the bins.

After three years of intensive exploration in many parts of the Islands to increase the known deposits of sand, a large supply of suitable sand was located on the Island of Palawan. Sand from this locality is now transported to the plant by barges. The sand is stored outside of the main raw materials processing building and conveyed to a bucket elevator hopper as required. This elevator delivers the damp sand to a surge bin of 420 cubic feet capacity that is provided with high and low level indicators and, by means of switches, these indicators control the operation of the elevator. A Bartlett-Snow sand dryer is fed by the surge bin through a Syntron vibratory feeder at a predetermined uniform rate of flow. The fines are removed by a cyclone dust collector at the discharge end of the dryer. The dried sand of less than 1% moisture discharges into a chute and bucket elevator

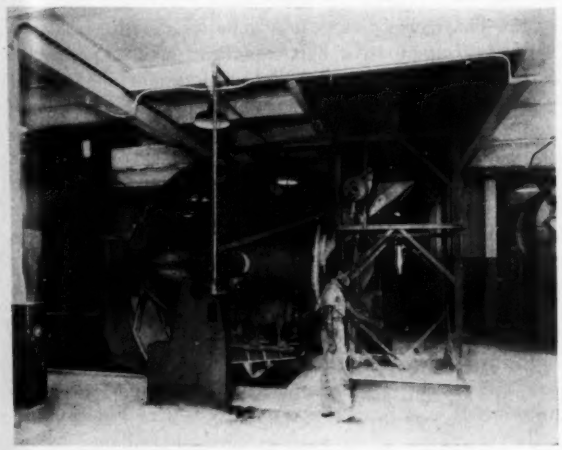
Side view of present furnace showing openings in floor for two future tanks.



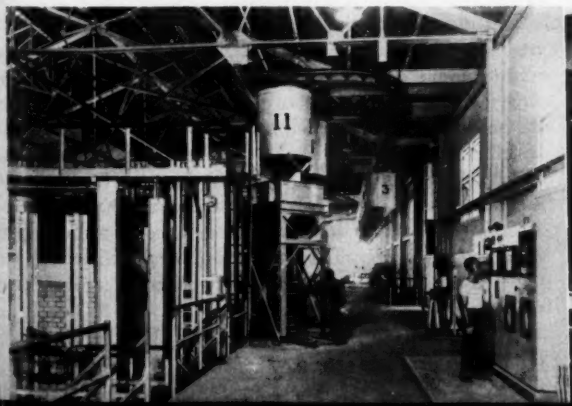
The complete automatic weighing and batch collecting system.

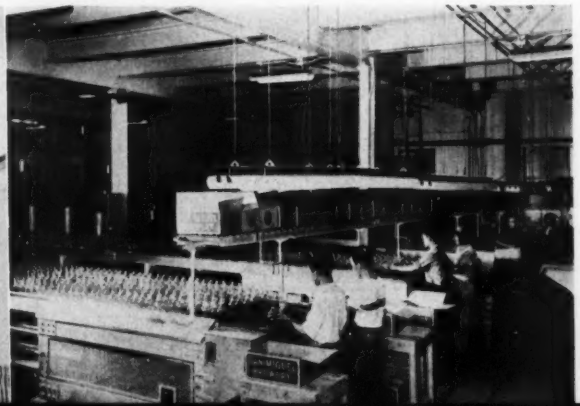


The 56 cubic foot T. L. Smith batch mixer.



(Left) Charging end of furnace showing automatic control instruments, batch buckets, tramrail and batch chargers. (Right) Discharge end of lehrs.





Read view of the factory showing the raw material processing and batch plant.

The main lobby leading into the offices of the San Miguel Brewery glass factory.

Offices are spacious and well lighted with glass block aiding light diffusion and contributing decorative qualities.

and is delivered to a 4′ x 10′ single surface Tyler hummer screen. The oversize is discharged to a waiting truck outside of the building. The sand of the proper grain size after passing through the screen is conveyed by gravity to a third elevator which places it in either one of two sand storage silos. Each silo has a capacity of 270 tons.

The lime is received in lumps direct from the quarry and is stored outside of the building from where it is taken to an outside hopper at ground level as required. From this hopper it is fed to a Telsmith jaw crusher by means of a pan conveyor at a predetermined rate, then after crushing, it is conveyed by means of a bucket elevator to a Tyler hummer double surface screen and all oversize retained on both the primary and secondary screen travel through a Sturtevant ring roll mill. After passing through the roll mill, the material returns to the same elevator that received it from the jaw crusher. By this method the limestone continues in a complete circuit until the proper size has been attained to permit it to pass through the secondary screen. From the secondary screen, it is conveyed to the storage bin. This bin has a capacity of 96 tons.

The soda ash is received in barrels by motor truck. A ramp for the trucks is provided inside the building to deliver the barrels directly into the soda ash storage room. The barrel storage area is 4,400 square feet and is served by an overhead 5-ton traveling crane. The soda ash barrels are conveyed by means of the overhead crane as required to a floor hopper feeding a bucket elevator that delivers the soda ash to the storage bin which has a capacity of 65 tons.

The cullet handling is completely mechanized. Cullet received from the gob feeders is dropped through the factory floor to waiting water cooled trucks in the basement. The trucks dump into a hopper in the basement floor feeding on to a belt conveyor which carries the cullet underground to the batch building. This conveyor is also provided with a hopper outside the building so that foreign cullet may be fed into the system. A 20-cubic-foot skip hoist receives the cullet from the belt conveyor and delivers it to a Telsmith jaw crusher located on the second floor of the batch house. From the crusher it discharges into a rotary cullet washer. The cullet continues by gravity through an intercone crusher and onto a magnetic belt conveyor for removal of all tramp iron. Provision has been made for drying the cullet if necessary on the magnetic belt conveyor. The processed cullet is then delivered by means of a bucket elevator to either one of two cullet storage bins with a capacity of 125 tons each.

The weighing of the various batch ingredients is completely automatic and controlled from one central panel. The ingredients are individually fed to weigh hoppers by means of Syntron vibratory weigh feeders which are controlled electrically by Toledo scales. After all of the ingredients have been weighed and recorded, the materials are fed simultaneously to a 24″ collecting belt by means of Syntron vibratory discharge feeders. From the collecting belt, the weighed batch materials are discharged into a bucket elevator and then to the batch mixer. The complete batch weighing and collecting system is dust-tight and all electrical controls so interlocked that it is impossible to deliver anything except the predetermined batch to the mixer. The system was designed to deliver one complete batch weighing 5,650 pounds every five

minutes with a total delivery of 67,800 pounds per hour. The T. L. Smith glass batch mixer has a capacity of 56 cubic feet and delivers the batch to the mixed batch elevator.

The whole system is interlocked electrically so that none of the automatic operations can take place unless there is a batch bucket under the bifurcated discharge chute of the mixed batch elevator and the special dust-proof hood has been clamped to the top of the batch bucket. This dust hood is so arranged that it can be clamped onto the bucket while the operator is standing on the working floor level.

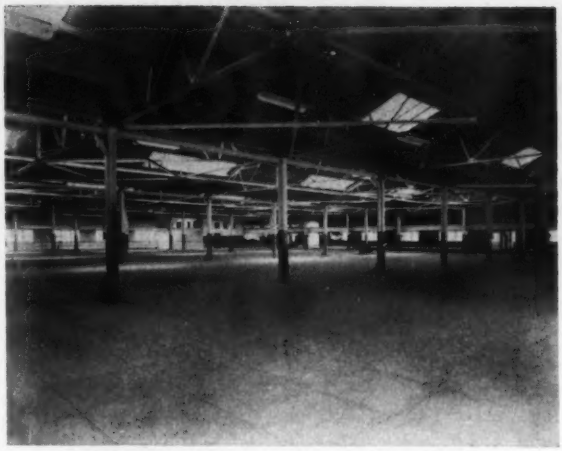
The mixed batch is conveyed to the furnace in the steel batch buckets which have a capacity of 60 cubic feet and are supported from trolleys which operate on a Cleveland Tramrail.

The batch buckets in the batch house are moved along the tramrail by means of a specially designed conveyor drive. This drive is interlocked with the dust hood mentioned above so that when a batch bucket has been filled by the mixed batch elevator and the operator releases the clamp on the dust hood the special conveyor automatically moves the next bucket under the mixed batch elevator discharge chute and all the filled batch buckets move forward one position. From the batch house, one or more filled batch buckets are moved to the furnace building by means of an electric tramrail tractor and the mixed batch automatically discharged into the hopper over the automatic batch feeders. This hopper is kept full of batch at all times, elminating drop of the batch from the buckets to the hopper, thus minimizing segregation. The empty batch buckets are propelled back to the batch house by means of the electric tramrail tractor where they are automatically picked up by the special conveyor drive and again started on their way to the mixed batch elevator. All batch conveying and elevating equipment was manufactured by Stephens-Adamson Manufacturing Company.

After melting and refining in the furnace, the glass is fed to the Lynch "10" Machines. The bottles are automatically taken out of the machines and placed on conveyors which transport the bottles to the automatic lehr loaders, then placed in the lehrs and annealed. At the discharge end of the lehrs, the bottles are placed in cartons and shipped to their destination. The present production is 160,000 bottles per day.

A complete carton manufacturing plant will be installed on the second floor above the lehrs and the cartons will be transferred to the discharge end of the lehrs by means of chutes. Also a complete decorating plant is being installed for applying ceramic labels and other decorations on the glass containers.

The plant has two laboratories, one for physical and the other for chemical determination, which are elaborately equipped with the most modern scientific instruments. Representative samples of all raw materials are analyzed in the laboratories to determine the composition, so that the batch can be adjusted to assure a uniformly high grade finished product. Samples of the finished product are taken from the production lines at intervals of thirty minutes day and night and likewise submitted to the laboratories where they are subjected to rigid physical tests and chemical analysis. The entire plant is staffed exclusively by Filipino engineers, technicians and labor personnel.



Room above lehrs which will house a complete carton manufacturing plant.

A corner of the chemical laboratory equipped for analysis of raw materials and finished ware.

The factory washroom which provides facilities as modern as the plant itself.

THE GLASS DIVISION AT SHAWNEE INN

The twenty-first autumn meeting of the Glass Division of the American Ceramic Society brought together at Shawnee-on-Delaware a large and representative group of technologists. More than 125 registrants enjoyed everything connected with the two-day session, October 6 and 7, except the weather. The Poconos ran to sneezes, so to speak, and the overcast of Thursday became a persistent misty drizzle on Friday that kept all but the most ardent golfers indoors.

The idea seems to gain acceptance that the expensive resort may not be the best place for one of these autumn meetings. One result of the high cost of attendance is that many younger members, particularly students, are quite unable to afford to come. Another year may see the choice of a city easily reached by rail where accommodations at low cost may be arranged for students and others not endowed with generous expense accounts.

At Shawnee, the Society was represented by President Hobart M. Kraner and Secretary Charles S. Pearce. Most of the group arrived before lunch on Thursday, in plenty of time for the start of the technical session. In fact, the competition of the World Series broadcast was so strong that some slight delay resulted. The program, arranged by Program Chairman E. C. Hagedorn, was neatly divided so that ample time was given for three papers on Thursday with two papers and the business session on Friday.

In their work on "Surface Tension of Molten Zinc Borates", Leo Shartsis and Rodrigo Canga, National Bureau of Standards, encountered some interesting behavior. For one thing, the mixtures low in zinc oxide form two immiscible liquids on melting so that the upper layer, really molten boron oxide, is the liquid whose surface tension is the one measured. This is true up to a major content of zinc oxide. Another point was that the surface tension for a given composition, instead of decreasing continuously with temperature rise, passed through a minimum and then rose again as temperature increased.

No great interest in zinc borate glasses exists just now, but it will be remembered that the study of a zinc borate composition led to the development of the old Jena apparatus glass that chemists liked in the pre-Pyrex days.

J. F. White and W. B. Silverman, Owens-Illinois Glass Company, studying the solarization of glass, found that iron content promotes solarizing by ultraviolet, but it also stops the penetration of the solarizing effect when the concentration of iron amounts to anything, and limits it to a surface skin.

The handsome new method of designating optical glasses appeared in the next title, "Annealing of 517:645 Borosilicate Optical Glass", by Neill M. Brandt, Bausch & Lomb Fellow, Mellon Institute. This means a glass of index of refraction 1.517 and nu value (reciprocal of dispersive power) of 64.5.

Dr. Brandt had done a painstaking piece of work demonstrating the effect of heat-treating for long periods at temperatures such as 520°, 530° and 540°C. on bringing the glass to different equilibrium conditions represented by progressively lower indices. At each temperature, one sample of glass was treated as received; another, after being thrown altogether out of equilibrium by a brief heat treatment above 600°C. The useful result of the experiments was the establishment of an annealing schedule for rather large pieces of the glass.

After dinner, Trustee Aaron K. Lyle presented the Frank Forrest Award to Miss Anna Harrison for her paper on the infrared transmission of glasses.

The guest of honor was Professor Adolph Smekal of Darmstadt, Germany. His papers on the strength of glass and methods of testing are well-known to American readers. Prof. Smekal spoke briefly of the revival of the German Society of Glass Technology and the resumption of its publication, "*Glastechnische Berichte*", under the editorship of Dr. H. Maurach.

Committee C-14, A.S.T.M., held a session later in the evening. A few reports of sub-committees were heard. The glossary, passed as a tentative standard by letter ballot, is now ready for publication by the A.S.T.M.

The first paper on Friday morning, "Influence of Heavy-Metal Ions on the Viscosity of Silicate Melts" by W. A. Weyl and T. A. Kupinski, Pennsylvania State College, was read by Mr. Kupinski in his first appearance before the Division. It seems that the heavy metals, i.e., Cu^{++}, Fe^{++} and the like, act to reduce viscosities, especially in small additions.

C. L. Babcock, Owens-Illinois Glass Company, continued the series of studies that have appeared from that

Professor Adolph Smekal of Darmstadt, Germany, pats Norbert Kreidl on the back—"one of the best students I ever had"—as Division Chairman Clarence H. Hahner, Aaron K. Lyle and Anna Harrison look on.

company's laboratory on the soda-dolomitic lime-silica glasses by reporting on what happens when potash and lithia replace part of the soda. Since one of these oxides has half-again the molecular weight of soda and the other only one-half, the effects of percentage-wise substitutions are exaggerated. The usual arguments over the virtues of molecular and percentage substitutions arose. Final publication of the paper will doubtless clear up these points.

In the brief business session, J. C. Hostetter, Mississippi Glass Company, reported, as the Division's representative, on the International Commission. It seems that a Congress is in view, perhaps in 1950, and that a part of the expense of operating the Commission ought reasonably to be borne by the Division.

Chairman C. H. Hahner, Bureau of Standards, presided over most of the technical sessions and business meeting. Vice-Chairman H. H. Holscher, Owens-Illinois Glass Company, practiced with the gavel on Friday morning. F. V. Tooley, University of Illinois, did efficient work as Secretary for the Division and for Committee C-14.

R. M. Curts of American Potash and Chemical Company, Golf Chairman, had a tableful of attractive prizes in the hotel lobby. Despite the inclement weather, twenty-three golfers, including three ladies, participated in the annual golf tournament of the Glass Division meeting. By dividing up boxes of golf balls which were donated by some suppliers, everyone received a prize, despite their scores.

Ken Henry, Kimble Division of Owens-Illinois Glass Company, won the low gross with an 84, and chose a beautiful Philco Radio donated by the Central Silica Company of Zanesville, Ohio.

Other prizes were awarded on the "Shawnee Handicap System" which computes handicaps based on the gross score and the worst holes, placing the majority of golfers between 70 and 80 net. Winners were Messrs. Bliss, Nordyke, Samson, Bates, Matthews, Love, Keaney, Pinotti, Curts, Wendt, Hehner, Houze, Clark, Ostrander, Hummel, Geutsch, Burris, J. J. Smith and Ferris.

Prize donors were Cohart Refractories Company, Consolidated Feldspar Company, B. F. Drakenfeld, Foote Mineral Company, Great Lakes Foundry Sand Company, Niagara Alkali Company, The Glass Industry, Pacific Coast Borax Company, Pemco Corporation, Stauffer Chemical Company, American Potash & Chemical Corporation, R. T. Vanderbilt Company, Walsh Refractories Corporation, Willson Products Company, Harshaw Chemical Company, National Lime & Stone Company, Central Silica Company, Ohio Hydrate & Supply Company and Dominion Minerals, Inc.

With permission of the donors, two prizes were allocated for a ladies' bridge tournament and were won by Mrs. du Bois and Mrs. Duncan, a total of eight ladies participating.

Brief summaries of the glass division papers follow:

Surface Tension of Molten Zinc Borates. *By Leo Shartsis and Rodrigo Canga, National Bureau of Standards, Washington, D. C.*

Zinc oxide and boric oxide are used extensively in glasses, glazes and enamels. It was considered, therefore, that a study of surface tension in this system of oxides might be of interest in several fields of ceramics. Furthermore, studies of simple systems are not only interpreted more easily, but also may be of use in the study of more complex systems. A further consideration in the selection of the system zinc oxide-boric oxide for study was the expectation of obtaining additional data for the positive temperature coefficients of surface tension. Previous studies had indicated that the phenomenon would probably occur in the present study.

Glass Division Trustee Aaron K. Lyle presents the Frank Forrest Award to Anna Harrison for her paper on the infrared transmission of glasses.

The surface tension of melts in the system ZnO-B_2O_3, ranging from 0 to 79.5 per cent of ZnO, were measured with a maximum pull-on-cylinder method. The surface tension values of zinc borate melts were practically constant within the two-liquid region extending from about zero to 53 per cent of ZnO and that of B_2O_3. With percentages of ZnO beyond the two-liquid region, the surface tension values increased rapidly with increasing ZnO content. According to the Gibbs adsorption isotherm, this indicates that the concentration of ZnO in the surface is less than that in the body of the liquid. This is one factor that would operate to cause a greater loss of B_2O_3 than of ZnO in melts heated at high temperatures as indicated by the analytical results.

With one exception, melts of all compositions had positive temperature coefficients of surface tension and those containing 55 to 65 per cent ZnO showed minima in the curves of surface tension versus temperature. Two theories regarding the cause of positive temperature coefficients of surface tension were reviewed.

Some Studies on the Solarization of Glass. *By J. F. White & W. B. Silverman, Owens-Illinois Glass Co., General Research and New Development Div., Toledo, Ohio.*

The work covers visible light transmission change due to solar and high pressure mercury arc radiation in a soda-lime glass when 0.15% of As_2O_3, CeO_2, MnO_2, and Sb_2O_3 are added. Included is the transmission at 1100 Mu showing the effect of these treatments. Effect of Fe_2O_3 is covered showing ultraviolet light transmissions for before and after treatment with mercury arc. In an attempt to get at the mechanism the penetration of glass color change was measured. Changing the basic composition was then done to show effect of alkali and substitution of BeO for CaO.

Results show for oxidizing agents Sb_2O_3 has the smallest change in color after ultraviolet radiation. Depth of penetration of color change due to mercury arc radiation is limited exhibiting a skin effect, whereas color change due to solar radiation appears to be continuous throughout the glass.

Replacement of Na_2O by Li_2O exhibits radical reduction of color change when subjected to mercury arc radiation.

A glass of Li_2O-BeO-SiO_2 exhibits no color change when subjected to mercury arc radiation.

Annealing of 517:645 Borosilicate Optical Glass. *By Neill M. Brandt, Bausch & Lomb Optical Company Fellowship, Mellon Institute, Pittsburgh, Pa.*

The refractive index of glass at room temperature is a function of its thermal history. Knowledge of the time-temperature-refractive index data enables time-temperature schedules to be derived for attaining 1) an index as close to the maximum, 2) a specific index in minimum time and 3) the highest index in a given time. It was the purpose of this study to present the approximate maximum and minimum indices, the lower and upper transformation temperatures, the change of index with time at consequent temperature, and the equilibrium index, obtained by quenching glass from various temperatures within the transformation range, of a borosilicate crown glass (517:645) which, upon analysis was found to have the composition: SiO_2, 68.6%; ZnO, 2.5%; BaO, 1.8%; Na_2O, 3.9%; K_2O, 10.0%; B_2O_3, 11.4%; Sb_2O_3, 1.3%; R_2O_3, 0.3% by weight.

From the experimental data was derived the room temperature index, n_T, versus temperature, T, curve. The curve n_T vs. T was compared with results obtained by other investigators on a borosilicate glass and on a crown. Tables and graphs were established for annealing a plate of 517:645 optical glass of any thickness up to 10cm. The suggested schedules are not the most rapid schedules but, from the practical standpoint, optically stable and homogeneous 517:645 optical glass may be produced in an optimum time.

Influence of Heavy Metal Ions on the Viscosity of Silicate Glasses. *By W. A. Weyl and T. A. Kupinski, Pennsylvania State College, State College, Pa.*

A recent paper by W. A. Weyl on the structural conditions which are responsible for ductility on brittleness brought out the profound influence which the polarizability of ions exerts upon mechanical properties. Brittleness means that flow processes are improbable, whereas ductility means that at room temperature, flow processes can take place or that the activation energy of viscous flow is low. Using NaCl, a relatively hard and brittle crystal, and AgCl, a soft ductile material of identical atomic structure as a basis, it was shown how the potential barriers of the flow processes are lowered if the noble gas ion Na^+ is replaced by one of the same size and identical charge, but having a more polarizable electronic configuration.

This principle must also apply to the low temperature viscosity of glasses. A cation of high polarizability must decrease the viscosity. In this work the divalent cations of the noble gas type were replaced by ions of the same charge, approximately the same ionic radius but different electronic structures.

The viscosities were measured by the fiber elongation method developed by H. R. Lillie. This method allows the measurement of viscosity between log 8 and log 14. The equipment and procedure were developed by J. P. Poole. A complete description of the apparatus appeared in the July 1949 issue of the *Journal of the American Ceramic Society*.

A base glass of the following composition was used in this study:

5 SiO_2
1 Na_2O
1 MgO

Several series of glasses were made in which the Mg^{2+} ion was gradually replaced by each of the divalent cations: Zn^{2+}, Co^{2+}, Cu^{2+}, and Mn^{2+} in steps of ¼, ½, ¾ and 1 mole.

In order to study the effect of Pb^{2+} on viscosity, a base glass of the composition 5 SiO_2, 1 Na_2O, 1 PbO was used, where the Pb^{2+} was replaced by Sr^{2+}. Pb^{2+} and Sr^{2+} have approximately the same size.

The complete substitution of ZrO for MgO in the soda-magnesia-silica glass showed a decrease of only 10°C for log viscosity 9. NiO showed a somewhat greater effect. The CuO exhibited the greatest decrease in temperature, while MnO lowered the temperature approximately half as much. In the case of the CoO and CuO glasses, the initial substitution of each oxide for MgO showed a greater decrease in temperature than succeeding substitutions.

The replacement of PbO by SrO increased the viscosity of the soda-lead-silica glass. The viscosity increase was more rapid with the higher concentration of SrO.

The table below presents a summary of the viscosity-temperature relationships for the glasses studied. In all cases the substitution of non-noble gas ions for the noble gas ions Mg^{2+} and Sr^{2+}, decreased the viscosity.

Viscosity temperature relationship of glasses in which the divalent ions were substituted for Mg^{2+}:

	Mg^{2+}	Zn^{2+}	Co^{2+}	Mn^{2+}	Cu^{2+}
log = 9.0	670°C	660	635	605	550
log = 11.0	607	597	567	545	490
log = 13.0	550	542	520	490	422

Substitution of Sr^{2+} for Pb^{2+}:

	Pb^{2+}	Sr^{2+}
log = 9.0	470°C	630
log = 11.0	427	580
log = 13.0	395	535

Effect of K_2O and LiO_2 on Properties of Soda-Dolomitic Lime-Silica Glasses. *By C. L. Babcock, General Research and New Development Division, Owens-Illinois Glass Company, Toledo, Ohio.*

Using procedures which have been described in previous researches from this laboratory, the effect of K_2O and LiO_2 on the physical properties of soda-dolomite lime-silica glasses were investigated. In three base glasses, the first containing 18% Na_2O, 10% CaO·MgO, and 72% SiO_2; the second 14% Na_2O, 12% CaO·Mgo, and 74% SiO_2; and the third, 14% Na_2O, 16% CaO·MgO, and 70% SiO_2; K_2O was substituted for Na_2O in amounts of 2, 4 and 6%. In two base glasses, the first containing 16% Na_2O, 10% CaO·MgO, and 74% SiO_2; and the second with 14% Na_2O, 12% CaO·MgO, and 74% SiO_2, LiO was substituted for Na_2O in amounts of 2, 4 and 6%.

From the data obtained, it was concluded that 1) in the case of liquidus temperature a) the substitution of K_2O for Na_2O results in a gradual increase in liquidus temperatures in the 16% dolomite lime glasses. A slight decrease in liquidus temperature results when a 2% substitution is made in the 12% dolomite glasses. Further substitutions have no appreciable effect. In the 10% dolomite lime glasses, a 2% substitution of K_2O for Na_2O does not appreciably change the liquidus temperature. Further substitutions result in a gradual decrease. b) The substitution of Li_2O for Na_2O in the 12% dolomite lime glasses causes a gradual reduction in liquidus temperature for the 2 and 4% substitutions. The liquidus temperature of the glass containing 6% Li_2O is identical to that of the base glass. No appreciable change in liquidus temperatures occurred when Li_2O was substituted for Na_2O in the 10% dolomite lime glasses. c) Diopside and devitrite are found as primary phases in the K_2O glasses. Except for the 10% dolomite lime glass containing 2% Li_2O, which has tridymite as its primary phase, all of the LiO_2 glasses have primary phases not identified by this laboratory.

2) In the case of coefficient of expansion (70-160°C), a) the substitution of K_2O for Na_2O causes a moderate decrease in expansion coefficient. b) The substitution of Li_2O for Na_2O causes a substantial increase in the expansion coefficient.

3) In the case of the deformation point, a) the substitution of K_2O for Na_2O increases the deformation temperature in all cases. The magnitude of the increase varies directly with the CaO·MgO content. b) The substitution of Li_2O for Na_2O causes a pronounced decrease in the deformation temperature in both series.

4) In the case of viscosity, a) the substitution of K_2O for Na_2O increases the viscosity throughout the given range in each of the three series. The magnitude of this increase is

(*Continued on page* 634)

PRINCIPLES OF AUTOMATIC CONTROL

By J. C. PETERS, Associate Director of Research
Leeds & Northrup Company, Philadelphia, Pa.

It is well known that some processes are easy to control, while others are extremely difficult. Just as the human operator requires more special knowledge and skill as the operation becomes more difficult, so must the automatic operator have special ability to cope with unfavorable situations. The primary purpose of this paper is to explain how the types of control action built into present day automatic controllers operate to achieve the desired results.

In the past, straightforward presentation of this subject was limited by lack of standardization of automatic control terms. This situation has been much improved since a list of recommended terms has been made available by the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers.* These terms will be used in this paper with the addition, in a few cases, of "non-standard" equivalents.

Elements of an Automatic Controller

Figure 1 is a diagrammatic representation of an automatic controller applied to a heating process. Terms in parenthesis are general terms which include the specific items listed next to them. The principles of control might be discussed without reference to any particular controlled variable or any particular type of control agent. However, a specific process is easier to visualize than a generalized process, and a heating process has been selected because temperature is, in many cases, the most difficult variable to control accurately.

Referring to Figure 1, the temperature of the hot junction of the thermocouple is indicated by a pointer on a scale of the control instrument and the temperature is simultaneously recorded as it changes with time.

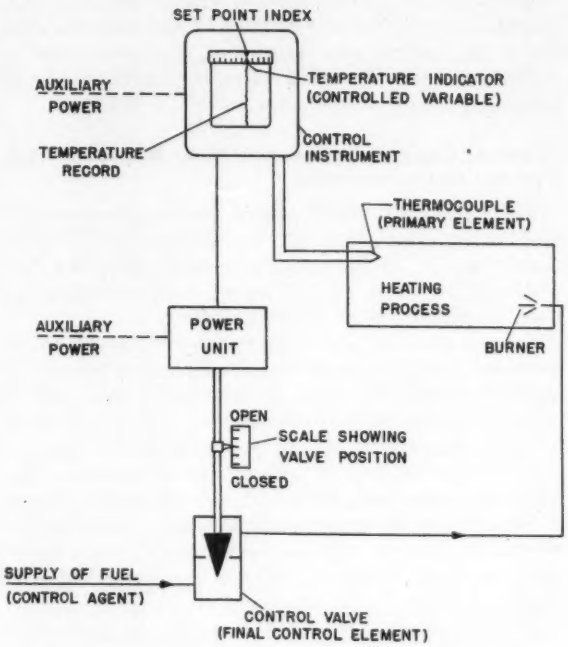


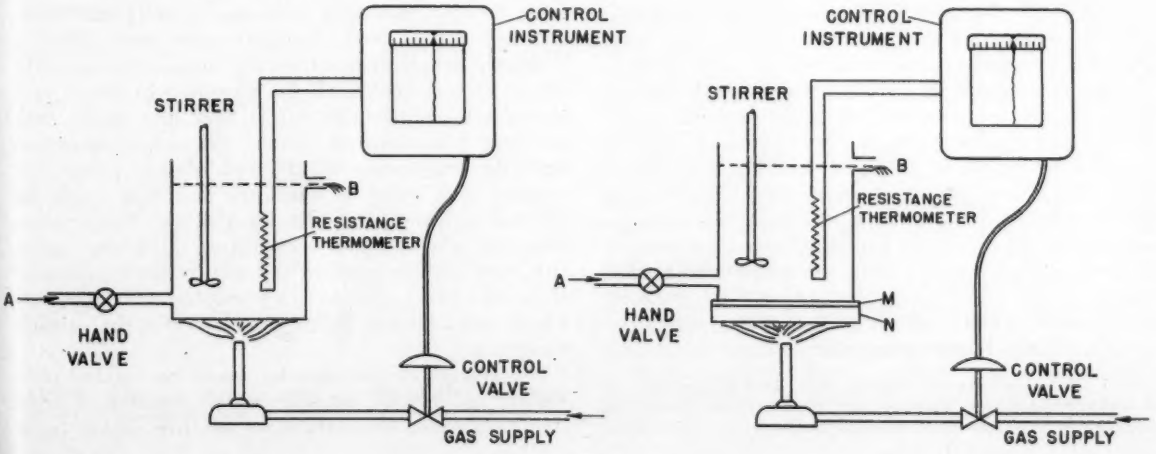
Fig. 1. Diagrammatic representation of a temperature control application.

Upon receiving indications of temperature from the measuring elements of the control instrument, the control elements direct the operation of the power unit to position the valve in accordance with predetermined laws. The power unit may be electric, pneumatic or hydraulic in type. If the operation is electric, it may involve an electric motor, or may be the solenoid of a solenoid-

Paper presented before the Tenth Conference on Glass Problems, Ohio State University, Columbus, Ohio.

*"Process Control Terms", *Mechanical Engineering*, vol. 66, 1944, pp. 205-206. Reprinted in the form of a 16 page booklet, available from American Society of Mechanical Engineers, 29 West 39th St., New York 18, New York.

Fig. 2. (a) Example of process easy to control. (b) Example of process relatively difficult to control.



type valve or of an electrical contactor. In pneumatic operation the most commonly used power unit is the "diaphragm motor," in which air pressure produces movement of a diaphragm against the force of a spring. Hydraulic and pneumatic cylinder arrangements are also used to move control valves.

For present purposes the particular mechanism is incidental. As the various types of control action are discussed, it may be helpful to think of the connection between the control instrument and the power unit as broken, and the prescribed valve movements produced manually, as the temperature record is observed.

Types of Control Action and Their Reaction with Process Characteristics

The following types of control action will be considered in the order listed: a) Two-Position. b) Proportional-Position. c) Proportional-Speed-Floating. d) Proportional-Plus-Reset. e) Proportional-plus-Reset-plus-Rate. f) Single and Two-Speed-Floating.

For processes that are extremely easy to control, either because accuracy of control is not required or because of highly favorable response characteristics, the simplest form of mechanism will often suffice. Control of other processes requires all the refinements that have been incorporated in the best of present day instruments. The need for various types of control action is readily shown by considering them as applied to simple processes for which the inherent response characteristics are evident upon inspection. Figure 2, (a) and (b), shows two very similar processes for the heating of oil.

The oil in each tank is stirred rapidly to insure uniformity of temperature throughout. Oil enters at A, is heated to a predetermined temperature, and flows out at B. The demand for heat is a function of the temperature of the incoming oil, its rate of flow, and the temperature to which it is to be raised.

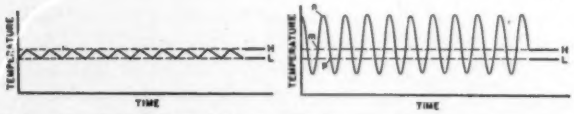


Fig. 3. (a) Two-position control record from process of Figure 2 (a). (b) Corresponding record for process of Figure 2 (b).

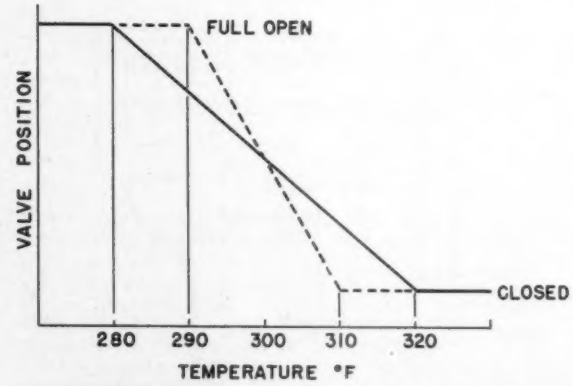


Fig. 4. Relation between valve-position and temperature in proportional-position control for proportional bands of 40°F (full line) and 20°F (dotted line).

For temperature measurement and control, a resistance thermometer in each bath is connected to a control instrument of the indicating and recording type. The output from the instrument is an air pressure which positions a diaphragm-motor-operated valve in the gas supply line.

The two processes of Figure 2 differ only in that for process (a) the gas flame impinges directly upon the bottom of the metal tank containing the oil, whereas for process (b) the flame is directed upon a thick slab of iron, N, with a layer of asbestos, M, separating it from the tank.

Two-Position Control. Now consider Two-Position (On-Off) control to be applied to each process, by incorporating this type of action into the design of the controllers, with set point for control adjusted to 300°F. Assume that with this setting the heat is turned on each time the temperature drops to 298°F and is turned off each time it rises to 302°F. The difference between the temperature at which the heat is turned off and the temperature at which the heat is turned on, is known as the "differential gap." In this case the differential gap is 4°F.

Since with two-position control the instantaneous heating rate is always either too high or too low, and changes in heating rate occur only when particular temperatures are reached, the temperature record is always cyclic. Records for the two processes of Figure 2 are shown in Figure 3. Record (a) is from process (a), and record (b) is from process (b).

With process (a) the temperature never rises appreciably above 302°F nor does it fall appreciably below 298°F. Temperature is almost instantly responsive to rate of gas supply.

The record for process (b) is quite different. Heat is cut off at a temperature of 302°F (point m) as for process (a), but the temperature continues to rise thereafter until it reaches a peak of 316°F (point n). It then gradually falls to 298°F (point p), at which temperature the gas is again turned on, but the temperature continues to fall till a minimum value of 292°F is reached.

The difference between the results obtained with the two processes is readily explained by the heat capacity of cast iron slab N and resistance to heat flow offered by asbestos sheet M. Actually the general effect would have been the same had the asbestos been omitted, because the iron represents both heat capacity and resistance to heat flow. Referring again to the curve of Figure 3 (b), the supply of heat from the burner is immediately cut off at (m) but slab N has already been heated to a temperature considerably higher than that of the bath and heat flow continues to raise the bath temperature, until the temperature of the slab has, at point (n), dropped to a value at which the heat flow would be sufficient to maintain the then existing tank temperature. Similarly, when the heat is turned on full-blast at point (p), some time is required to build up the temperature of the slab to the point at which heat transfer to the tank would again be just sufficient to maintain the existing temperature.

The amount of overshooting would be reduced only slightly by reducing the differential gap from 4°F to practically zero. The only other effective change to be

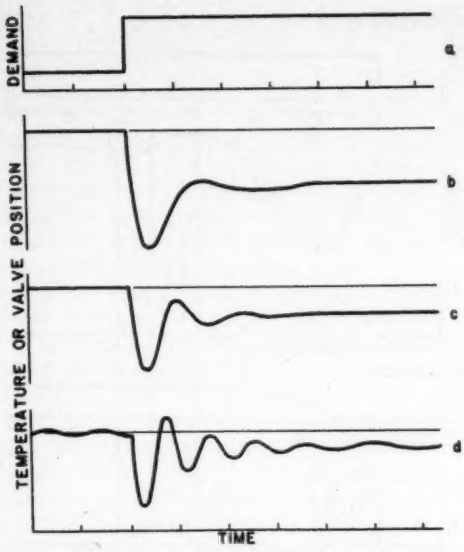


Fig. 5. Proportional-position control records showing the effect of successive decreases in the proportional band.

considered with two-position control is that of bringing the two heating rates nearer to the average rate required for normal operation. This would reduce the overshoot but correspondingly reduce the range of demand changes that could be automatically handled. The only satisfac tory solution lies in a different type of control action

Proportional-Position Control. This type of control is often referred to simply as "proportional control." Its action may be visualized by thinking of the control valve stem as mechanically connected to the temperature indicating pointer, through a suitable linkage, the power

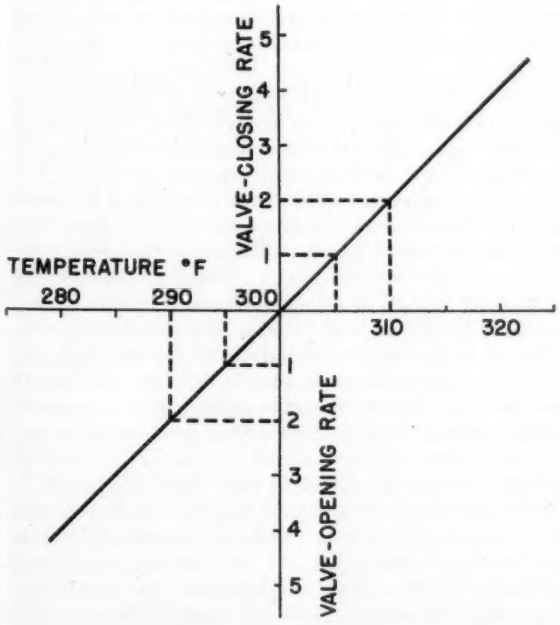


Fig. 6. Relation between rate at which valve opens and closes, and temperature, in proportional-speed-floating control.

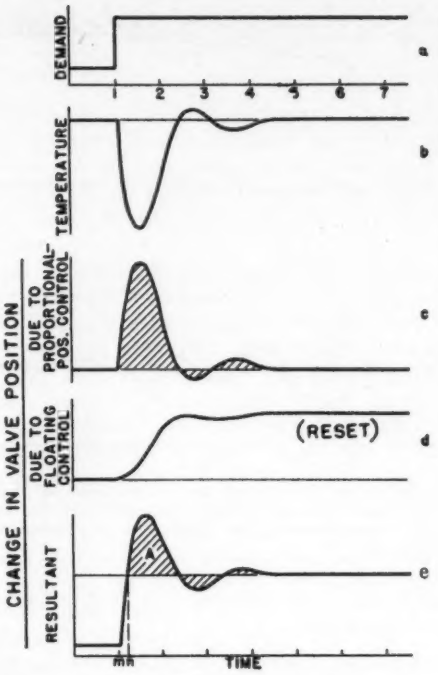


Fig. 7. Graphical analysis of proportional-plus-reset control.

behind the pointer being sufficient to move the valve. Figure 4 shows how valve position is related to temperature. Considering the full-line curve, the valve is full-open when the temperature is 280°F and completely closed at 320°F. For intermediate temperatures the valve has intermediate openings. The temperature range covered in changing the valve position from open to closed is the "proportional band" or "throttling range." It is 40°F for the full-line curve and 20°F for the dotted-line curve. Many controllers are provided with means for adjusting this relationship over a wide range. Calibration of the adjusting means is usually in terms of percent of full-scale-range of the instrument.

The curves of Figure 5 are for proportional control applied to the process of Figure 2 (b). To obtain them the heat load was suddenly increased by increasing the rate of oil flow into the tank. This sudden change in demand is represented by curve (a). The sudden change of demand was repeated for three different proportional band settings. Referring to curve 5 (b), it is seen that after the initial disturbance the temperature settled down to a steady value below that of the original temperature. This change in controlled temperature with change in demand is characteristic of proportional control and is known as "offset" or "droop." To obtain curve (c) the proportional band was halved. The resulting offset is approximately half that of curve (b) and it is noted that there was a tendency toward cycling, as the temperature settled down to the new value. A further decrease of the proportional band to half of that for curve (c) resulted in a further decrease in offset as seen from curve (d), but at this point continuous cycling of small magnitude was encountered. This condition always sets a limit upon the extent to which the proportional band can be narrowed. If the temperature must be held closer than

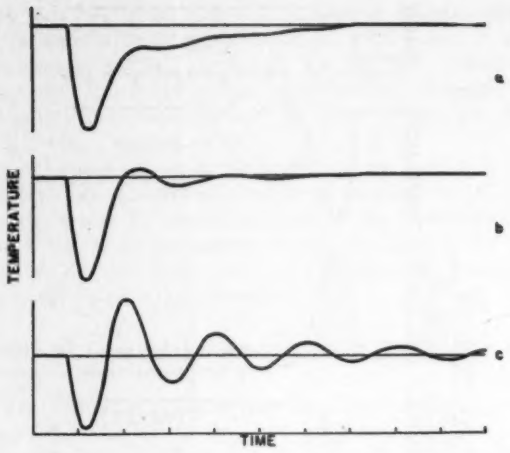


Fig. 8. Effect of increasing the magnitude of the reset action in proportional-plus-reset control — (a) not enough reset; (b) correct amount of reset; (c) oscillations due to too much reset.

is possible without undue cycling, a floating control action must be added.

Proportional-Speed-Floating Control. With floating control action there is a predetermined relationship between rate-of-motion of the control valve, and temperature. With the particular form known as "proportional-speed-floating," the valve is moved at a rate proportional to deviation from the desired temperature and in the direction required to return the temperature to the set point for control. This relationship is shown graphically in Figure 6. The valve-opening-rate and valve-closing-rate scales are in arbitrary units. In actual instruments the rate of valve movement corresponding to a given deviation is usually adjustable.

Referring to Figure 6, the set point for control is 300°F. When the temperature is 5°F below the set point (295°F) the control valve is continually opened at unit rate. A deviation of 10°F calls for valve movement at twice this rate, etc. The rate of movement is the same regardless of whether the temperature is 10°F high or 10°F low, but in the first case the valve is closing and in the second case it is opening.

Proportional-Speed-Floating control is not used alone to control temperature, but is added to proportional control to obtain close control without cycling. This combination is referred to as Proportional-plus-Reset Control or Proportional Control with Droop-Correction.

Proportional-plus-Reset Control. The curves of Figure 7 represent an analysis of what happens when a sudden load change is taken care of by proportional-plus-reset control. Referring to those curves, a demand change takes place at time 1. As a result, the temperature deviates from its normal value and is brought back by the action of the control system as indicated by curve (b). In the meantime, the valve has moved as shown by curve (e). Curve (c) shows the component of the valve motion due to proportional-position control. The form of this curve is the same as that of the temperature curve. This action has no permanent effect in determining the new valve position, serving merely to increase the valve opening while the temperature is decreasing, and to

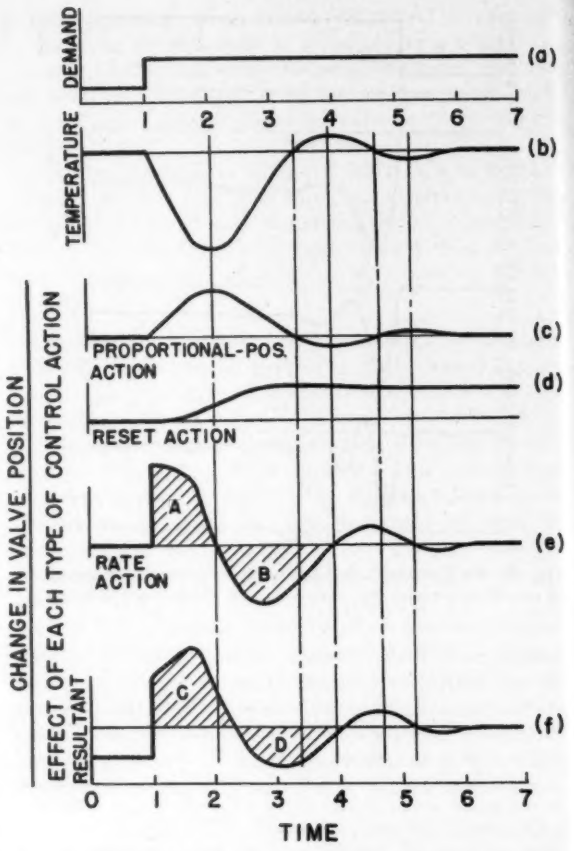


Fig. 9. Graphical analysis of proportional-plus-reset-plus-rate control.

decrease the valve opening while the temperature is increasing; the net effect, as a result of deviation from and subsequent return to normal temperature, being zero. The floating-control component, as shown by curve (d), acts to open the valve as long as the temperature is low, the assumed rate of movement being at all times proportional to deviation from normal. Floating control is entirely responsible for establishing the new valve position required by the changed demand.

For present purposes, curves (c), (d), and (e), may be considered as representing rate of heat supply as well as valve position. With this assumption, the areas under the curves represent quantities of heat, and the shaded area under curve (c) represents a block of heat energy put into the system in the course of stabilizing the temperature under the new conditions of demand. In curve (e), area A represents a quantity of heat applied in excess of the ultimate demand requirements. It serves to replace stored energy lost during the period m to n, during which the demand exceeded the supply, and also to increase the energy stored in slab N of Figure 2(b), which must now have a higher temperature, as required for increased rate of heat transfer to the tank to handle the increased demand. There is a certain amount of automatic compensation in the sense that while the temperature is low, heat is being removed from the system at a decreased rate. But for this self-controlling effect, it would be necessary that area A be greater than it is.

(*Continued on page* 632)

UNBREAKABLE GLASS?

Unbreakable glass has long been sought by many inventors and glass manufacturers but so far as we can learn, no one has yet discovered how to make it. However, now the Patent Office has granted a patent in which "unbreakable glass" is an essential element. The glass manufacturers would like to know what this unbreakable glass is, how to make it or where to buy it.

We refer to Patent No. 2,474,856 granted July 5, 1949 to Ernst H. Moseley of Detroit, Mich. The title of this patent is "Spectacle Temple of Unbreakable Glass." Glass manufacturers are not interested in spectacles but they are interested in any new glass.

The word "unbreakable" or "non-breakable" glass occurs in this patent no less than eight times and it occurs in both of the two claims. The patent gives no clue as to what this material may be and the file of the application in the Patent Office gives no information. The application resulting in this patent was divided from an earlier application filed December 7, 1945 which apparently has not yet been issued as a patent and, therefore, is not open to inspection. This does not affect the question as every patent must stand on its own feet; that is, its own disclosure.

The fact that the patent appears to us to be invalid on its face does not affect the question raised. A valid patent must include a description of the invention such as "to enable any person skilled in the art or science to which the invention or discovery appertains * * * to make, construct, compound, and use the same." How can anyone make use of an invention which includes as an essential element an unknown, or at least, an unidentified material?

The expression "unbreakable glass" naturally first suggests tempered glass or a plastic. But tempered glass is *not unbreakable* and plastic, in the usual sense of the word, is *not glass*. The fact that tempered glass can be broken, although with some difficulty, is one that is well known.

If this "unbreakable glass" is really a plastic, then it is very pertinent to consider the case brought by the Federal Trade Commission against S. Buchsbaum & Company of Chicago. (See THE GLASS INDUSTRY for January 1942, page 25.) This company was selling goods under the trade name of "Elasti-Glass" which the testimony showed to be made from a synthetic resin product known as Vinylite. The Federal Trade Commission claimed that this plastic material could not properly be described as glass in any trade name entering into interstate commerce.

A very clear definition of glass was established in the above case by Dr. John C. Hostetter who quoted the definition promulgated by the American Society of Testing Materials: "Glass is an inorganic product of fusion which has cooled to a rigid condition without crystalizing." There can be no question as to the distinction between glass and plastics such as Vinylite.

But now we have another government agency, that is the Patent Office, granting a patent which includes as a necessary element, "unbreakable glass." We have no means of knowing what this remarkable glass is. One might guess that it is not glass at all but a plastic. Whatever it may be, an explanation is due the glass manufacturing industry and THE GLASS INDUSTRY will make every effort to obtain it.

TWO BOOKLETS OFFERED BY DEPT. OF COMMERCE

The testing of materials with the electron microscope is the subject of a manual now available from the Office of Technical Services of the U. S. Department of Commerce. The manual is a basic introduction to the nature of the electron miscroscope and its contribution to various types of materials problems.

According to the manual, the ability of the electron microscope to reveal visually the size, distribution and shape of particles in the submicroscopic region is of particular importance in accounting for many of the physical and chemical properties of materials. An explanation is provided of the limitations of light microscopes in this realm.

The manual provides practical information of the construction and operation of the electron microscope and the preparation of replicas and specimens. The report contains a number of photomicrographs, as well as graphs and illustrations. To order: PB 97957, "The Electron Microscope and Its Application to Materials Problems", 48 pages, $1.25 per copy. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

Also just published by the Department of Commerce, National Bureau of Standards, is a booklet, "Testing of Hydrometers", now available from the U. S. Government Printing Office.

In the booklet, the various scales commonly used for hydrometers are defined, and recommendations are given for subdividing and marking them. These scales include density, specific gravity, degrees Baume, degrees API, percentage by weight, percentage by volume, percentage proof spirit, Brix, Balling and others. Instructions and other helpful information about submitting hydrometers for test are given.

To order the booklet: Circular C477, "Testing of Hydrometers" by Elmer L. Peffer and Mary G. Blair, 9 large double-column pages, illustrated, 10 cents a copy. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

• James C. Diehl, General Purchasing Agent of Libbey-Owens-Ford Glass Company, took part in the five-man round table commodity discussion at the annual sixth district conference of the National Association of Purchasing Agents.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Annealing

Annealing Composite Glass and Metal Articles. Fig. 1. Patent No. 2,482,734. This invention by Ronald J. McKenzie, Addison B. Scholes and Stanley E. Lull was assigned to Sylvania Electric Products, Inc.

The pieces to be annealed may comprise a glass disc enclosed by a metal ring and having lead wires passing through the glass, all as shown in Patent No. 2,342,609 to Bennett S. Ellefson, which are indicated at 17. The pieces 17 are taken from the sealing mechanism and placed on supports 4 attached to a conveyor 5 which carries them through a refractory chamber 6.

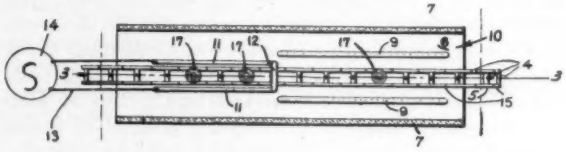


Fig. 1. Annealing Composite Glass and Metal Articles.

The piece may not be quite hot at the start and in order to heat it slowly to a uniform temperature, gas heaters 9 are placed near the input end 10 of the chamber. After leaving the gas heaters, the metal parts tend to cool more rapidly but at this time the pieces enter the field of parallel radio frequency conductors 11 connected to a radio frequency oscillator or generator 14. These conductors retard the cooling of the metal parts but have little or no effect on the cooling of the glass. In this way, a well annealed piece is provided having no dangerous strains.

The following references are of record in the file of this patent: United States Patents: 1,566,500, Northrup, Dec. 22, 1925; 1,899,640, Schwalbe, Feb. 28, 1933; 2,301,940, Fries, Nov. 17, 1942; 2,308,240, Goodridge, Jan. 12, 1943; and 2,328,225, Morey, Aug. 31, 1943.

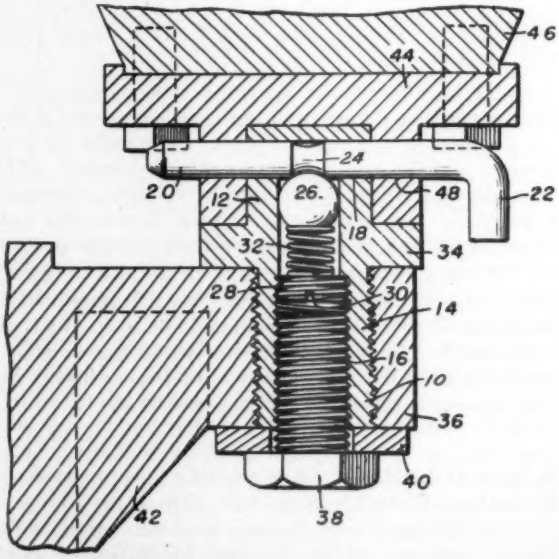


Fig. 2. Mold Attaching Device.

Feeding and Forming

Mold Attaching Device. Fig. 2. Patent No. 2,483,660. This invention provides means for attaching a mold to a forming machine such as used in the manufacture of glass jars and it is the invention of Harry J. Morris and Lewey Peters of Okmulgee, Okla.

The device comprises a sleeve 12 having an outside thread 14 and an inside thread 16. A locking pin 22 extends through the top of this sleeve and it has a groove 24 to engage a ball 26 which is urged upwardly by a spring 32 seated against a plug 28. The sleeve 12 is a part of a member 34 threaded into the mold carrier arm 42. The mold 46 is secured to a retainer 44.

The pin 22 can be readily inserted and removed through the holes provided so as to allow an easy and quick means for removing the mold for inspection or replacement.

The following references are of record in the file of this patent: United States Patents: 1,502,528, Reulbach, July 22, 1924; 1,869,249, Gray et al., July 26, 1932; and 2,365,928, Allen, Dec. 26, 1944.

Glass Wool and Fiber

Crucible For Making Glass Fibers. Fig. 3. Patent No. 2,482,299. This patent shows a crucible or melting tank from which glass fibers may be drawn. It is the invention of Charles R. Stevens, Toledo, Ohio, who assigned it to Glass Fibers, Inc., Waterville, Ohio. The apparatus is adapted to draw fibers from .00025 to .0003 inches in diameter.

The crucible shown in the figure comprises an outer cylindrical wall 10 and an inner wall 11 between which there is an annular orifice plate 12 perforated by a large number of small holes 13 through which the glass extrudes. The inner wall 11 supports a planing plate 14 having a central depression 15 and a raised edge 16 over which the molten glass flows during operation. These parts are preferably made of platinum or platinum-rhodium alloy.

These parts are enclosed in a refractory insulating casing including the wall members 22 and 23 and a top plate 31 having an opening 32 for the introduction of raw materials. Forming a part of this casing there is an induction coil 20 which forms a hot edge at 16 over which the molten glass flows to the drawing chamber 18 to which gas under pressure is admitted through a pipe 33. The wires 35 and 36 indicate connections to an electrical device for controlling the delivery of batch and thus the glass level.

By this construction an extrusive pressure is exerted on the glass above the orifices 13 thereby causing a large number of fine fibers of uniform diameter to be drawn out.

The following references are of record in the file of

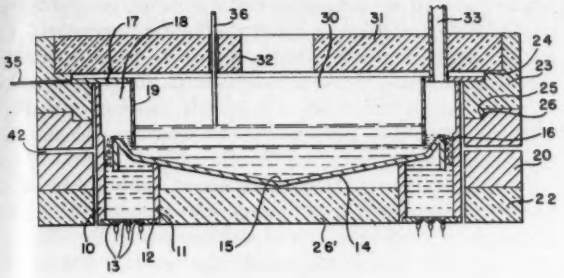


Fig. 3. Crucible for making Glass Fibers.

this patent: United States Patents: 2,159,361, Atkinson et al., May 23, 1939; 2,181,030, Thomas, Nov. 21, 1939; 2,229,489, Barnard, Jan. 21, 1941; 2,331, 946, Von Pazsiczky et al., Oct. 19, 1943; 2,398,952, Nachod, April 23, 1946; and 2,408,229, Roberds, Sept. 24, 1946.

Glass Fiber Filter. Fig. 4. Patent No. 2,484,003. Allen L. Simison made this invention and assigned it to Owens-Corning Fiberglas Corporation. The patent is a continuation in part of the application resulting in Patent No. 2,311,704. Parallel fiber filters of the type shown in this patent are also shown in Polushkin Patent No. 1,-865,762 and Swiss Patent No. 129,574 of 1929.

The prior patent to Simison discloses a bundle of glass fibers all extending generally in the length of the bundle, held in place by a metal tube. This tube is objectionable both as to cost and when the filter is used for certain chemical purposes. The present invention holds a bundle of parallel fibers together by fusing at least the outside layers.

Fig. 4 is a greatly enlarged view of glass fibers made into a filter in accordance with this invention. The fibers are first arranged in parallel formation and compressed by enclosing them in a split tube and closing the tube upon them. The tube is then heated sufficiently to fuse the outer layers of fiber together or if desired, the heat may be sufficient to fuse the fibers to a greater depth. In the figure, the fused surface of the bundle of fibers is indicated at 21 while the points indicated by the numeral 22 show where the adjacent fibers 11 are softened only

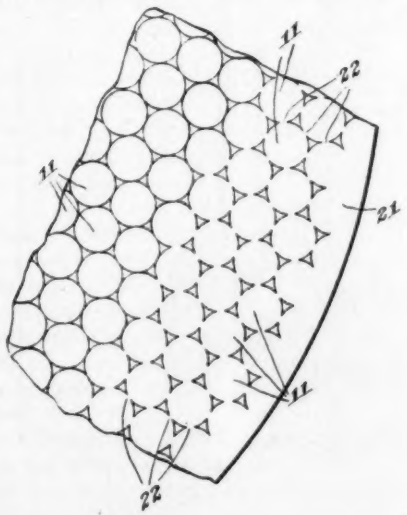


Fig. 4. Glass Fiber Filter.

enough to cause them to stick together. The inner fibers have been subject to no fusing whatever. The bundle thus formed is cut into slabs which may be used for filters or for other purposes.

The following references are of record in the file of this patent: United States Patents: 2,271,829, Powers, Feb. 3, 1942; 2,311,704, Simison, Feb. 23, 1943; and 2,328,302, Simison, Aug. 31, 1943. Foreign Patents: 425,413, Great Britain, Mar. 11, 1935.

Miscellaneous Processes

Glass-to-Metal Seal. Patent No. 2,480,453. This patent relates to the manufacture of discharge tubes, incandescent lamps and other devices where it is necessary to make a seal between glass and metal. It was invented by two citizens of Netherlands, Eduard G. Dorgelo and Hendricus J. Lemmens, who assigned it to Hartford National Bank and Trust Company, Hartford, Conn., as trustee.

The patent is directed to a method of preparing the metal for sealing rather than the sealing process itself and this method consists in heating a chrome iron conductor coated with a layer of another material for some time in a non-oxidizing atmosphere, at a temperature of about 800 to 1100° C., in such a manner that chromium diffuses out of the core body to the outside and deposits as a thin layer on the outer side of the body.

One example of the use of this method is as follows: A chrome iron wire to be used as a supply wire for short-wave tubes is coated electrolytically with a thin layer of copper of 20 microns and then heated at 1000° C. for 45 minutes in a reducing furnace; the conductor is then coated with a thin grey film of chromium oxide. The wire thus obtained is now sealed into a pinch or into a glass part formed in some way or other in the wall of an electric discharge tube; after that the tube is finished in a well-known manner. By this method of preparing the metal a much better seal can be made than has heretofore been possible.

The following references are of record in the file of this patent: United States Patents: 1,578,254, Bennett, Mar. 30, 1926; 1,989,236, Laise, Jan. 29, 1935; 2,044,-742, Armstrong et al., June 16, 1936; 2,156,262, Fink et al., May 2, 1939; 2,219,738, Copson, Oct. 29, 1940; 2,334,020, Miller et al., Nov. 9, 1943; 2,394,919, Kingston, Feb. 12, 1946; and 2,402,834, Nachtman, June 25, 1946. Foreign Patents: 554,004, Great Britain, June 15, 1943.

Vacuum Tube Assemblying Machine. Fig. 5. Patent No. 2,477,332. This machine for sealing the glass envelopes to the metallic base member of vacuum tubes so as to prevent leakage is the invention of Howard W. Garbe, Hinsdale, Ill., who assigned it to Western Electric Company.

The machine includes a vertical rod 77 arranged to be rotated by a belt 44 engaging a pulley 45. The belt may be driven by either one of two motors, one of which drives it at low speed and the other at a manually adjustable high speed. A chuck is mounted on the upper end of the rod and is constructed so as to support the metallic tube element 56 and the glass tube element 85, the lower end of which is heated by gas burners 86. The glass tube has a groove 87 near the bottom so that when this tube is heated to the softening point, located

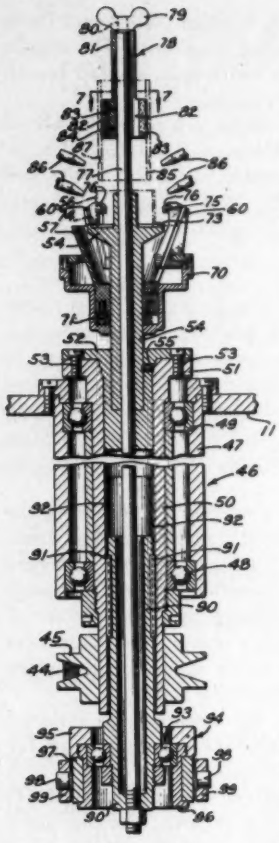


Fig. 5. Vacuum Tube Assembling Machine.

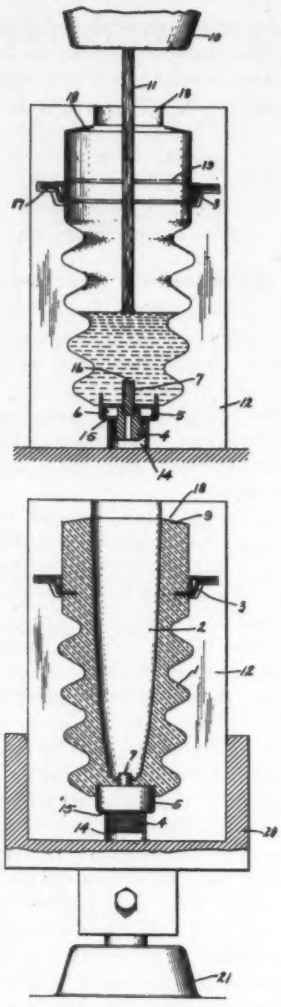


Fig. 6. Centrifugal Casting of Glass Bushings.

within the tube 56 and rotated at high speed, the bottom edge will be thrown out by centrifugal force into contact with the metal tube. The two parts are held in this position for a short time in order to insure a good seal.

The patent gives full details for construction and operation of the machine.

The following references are of record in the file of this patent: United States Patents: 1,124,386, Bartlett, Jan. 12, 1915; 1,547,478, Whitmore et al., July 28, 1925; 1,701,758, Mailey et al., Feb. 12, 1929; 1,844,936, Hotchkiss, Feb. 26, 1932; 1,862,856, Johnson, June 14, 1932; 1,942,042, Zimber et al., Jan. 2, 1934; 1,951,875, Laabs, Mar. 20, 1934; 2,029,094, De Vlieg et al., Jan. 28, 1936; 2,040,602, Eitel, May 12, 1936; 2,105,914, Fritzsch, Jan. 18, 1938; 2,271,658, Miller, Feb. 3, 1942; 2,296,347, Hinkley et al., Sept. 2, 1942; 2,306,054, Guyer, Dec. 22, 1942; 2,350,220, Ehret, May 30, 1944; and 2,374,269, Breadner et al., Apr. 24, 1945. Foreign Patents: 217,716, Switzerland, Feb. 16, 1942.

Centrifugal Casting of Glass Bushings. Fig. 6. Patent No. 2,478,624. Donald F. De Vine of Portland, Oreg., assigned this invention to General Electric Company. Such bushings consist of metal parts sealed into a glass insulator and it is highly important that this seal be tight.

The bushing consists of a main body of glass 1 having a central hollow space 2 and outer petticoats. A metal flange 3 and a member 5 are embedded in the glass, a terminal 4 being secured to the member 5. A tube 7 is provided for a lead, all these parts being made of an alloy having the necessary coefficient of expansion.

In making this bushing, a stream of glass 11 from a furnace 10 runs into a split mold 13 which supports the metal parts. The tube 7 is closed by a plug 16. When sufficient glass has accumulated, the mold is placed in a chuck 20 arranged to be rotated rapidly about a vertical axis. This causes the soft glass to assume the shape shown in the lower part of the figure. After the glass has set, the mold is removed and the bushing is annealed. The plug 16 is then driven out and the bushing is ready for further operations.

The following references are of record in the file of this patent: United States Patents: 113,393, Brookfield, Apr. 4, 1871; 144,061, Cate, Oct. 28, 1873; 793,299, Jewett, June 27, 1905; 1,190,145, Gift, July 4, 1916; 2,201,049, Moore, May 14, 1940; 2,221,695, Robertson, Nov. 12, 1940; 2,350,052, Luertzing, May 30, 1944; and 2,405,425, Higgins, Aug. 6, 1946.

Glass-to-Metal Sealing Machine. Fig. 7. Patent No. 2,480,364. This invention by Carl E. Hansen and James W. Juvinall was assigned to Western Electric Company. It relates particularly to aligning and sealing glass windows in aperatured cup-shaped metal parts of vacuum tubes.

The inverted metal cup 15 has a central aperature 16

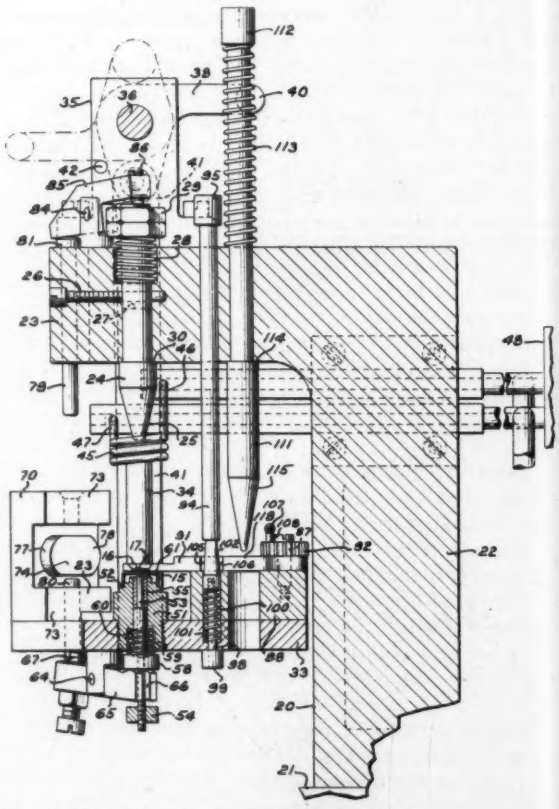


Fig. 7. Glass to Metal Sealing Machine.

to receive an optical glass window 17. A frame 20 has an overhanging arm 23 in which is mounted a vertically movable plunger 24, this plunger being held in raised position by a spring 28 and held from rotary movement by a pin and slot device 26. Below the arm 23 is a horizontally movable table 33 which can be raised and lowered by a handle 40. A stationary high frequency coil 45 so positioned that it surrounds the lower end of the plunger 24 and the cup 15 at certain times.

A lever 65 is arranged to be actuated to raise an anvil 55 for the pressing operation upon the glass. Means is provided for centering the window with the aperture in the cup. A spring supported plunger 111 is arranged to open levers 91 to provide positioning means for locating the glass window. With the cup and the window properly positioned, the table 33 is elevated to bring the parts into the heating coil 45 where the glass is softened and the pressing operation takes place. In this way the window is properly positioned with relation to the cup and a good seal is formed between them.

No references were cited by the Patent Office.

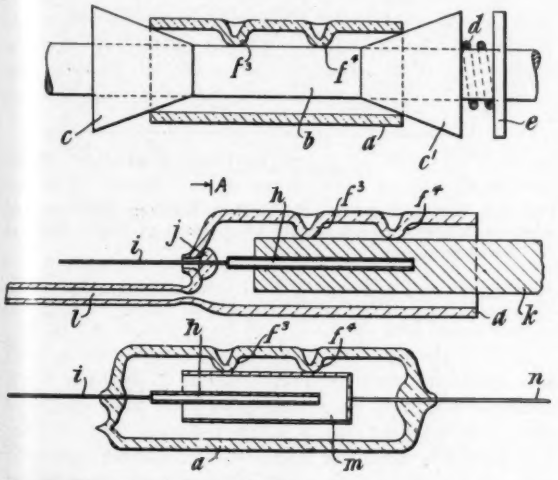


Fig. 8. Electric Discharge Tubes.

Electric Discharge Tubes. Fig. 8. Patent No. 2,481,906. This is the invention of two English gentlemen, Arthur L. Chilcot of Temperley and Sydney Jackson of Chadderton. The invention is particularly useful in the manufacture of so-called midget tubes.

At the top of the figure there is shown a glass tube A placed on a mandrel B where it is held by cones C and C^1, the latter being urged to the left by a spring D. The tube has six internal protuberances, two of which are shown at F^3 and F^4. These serve to center the tube on the mandrel which is the same size as a jig K later introduced and holding the anode H. One end of the tube has previously been closed except for a small opening through which a wire I is passed. This wire has a bead J which is fused to the tube thus holding the anode H rigidly in position. An exhaust tube L is also fused to the tube.

A cathode M having a wire N is inserted through the open right end of the tube where it is accurately located by the six internal protuberances after which the wire is fused to the tube. The tube is then exhausted and activated in the usual manner.

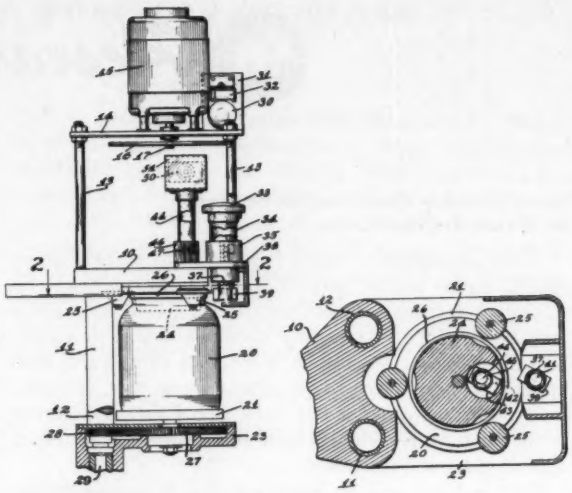


Fig. 9. Glassware Inspecting Device.

It is noted that this patent expires April 18, 1962.

The following references are of record in the file of this patent: United States Patents: 1,295,481, Greiner et al., Feb. 25, 1919; 1,558,883, Housekeeper, Oct. 27, 1925; 1,820,392, Hotchner, Aug. 25, 1931; 1,858,737, Hendry, May 17, 1932; 1,971,147, Whitman, Aug. 21, 1934; 2,030,185, Rose, Jr., Feb. 11, 1936; 2,104,166, Pelton, Jan. 4, 1938; 2,121,615, Vatter, June 21, 1938; 2,225,726, Veszi, Dec. 24, 1940; 2,256,101, Muller, Sept. 16, 1941; and 2,288,861, Wastrous, Jr., July 7, 1942.

Glassware Inspecting Device. Fig. 9. Patent No. 2,481,863. This invention was assigned to Owens-Illinois Glass Company by Elliott R. Owens of Whittier, Calif. The object of the invention is to detect defects such as crizzles, checks, fire cracks and so forth, on or near the surface of the glass, particularly on the sealing surface. Any such defect is apt to cause a slow leak after the container is sealed.

The figure shows a platform 10 connected by rods 13 with an upper platform 14 carrying an electric motor 15. This motor drives a light chopper disk 16. The jar 20 to be inspected is placed on a disk 21 arranged for vertical movement. When the jar is raised, it is centered by a conical block 24 and the periphery of the finish is engaged by conical rolls 25 which center the jar as it rotates. The mechanism for raising and lowering the jar may be the same as disclosed in the patent to Fedorchak No. 2,355,719.

The source of light is a lamp 30 having a reflector 32 which directs the light to a condensing lens 33. The light then passes to a box 39 in which is a prism of glass having inclined reflecting surfaces 41. A second reflecting prism 42 is located in a box 43 on the lower end of a tube 44. The arrangement is such that when any defect is found on the surface of the glass, a beam of light is transmitted to a photocell 50.

The light chopper disk 16 is an aluminum disk having fifteen holes and rotates at 3450 R.P.M. which gives 862 flashes of light per second. This is one convenient device which has been found satisfactory. When the flash of light indicates a defect, an ejector mechanism is made operative to throw out the jar. This ejector may be as

(*Continued on page* 624)

GJ Research Digest

Spot Test for Chemical Resistance of Enameled Surfaces

When an enamel or glass is exposed to an acid or an alkali, some of its soluble constituents may be removed. A transparent residual film of amorphous silica may be developed depending upon the degree of attack. The film, when viewed at an angle with white light, may appear to be colored. This phenomenon was observed many years ago and it has been stated that iridescence is the first form of attack and is followed by dullness, loss of gloss and roughness.

This multicolored or iridescent film is caused by the interference of light rays reflected from the upper and lower surfaces of the film, a fact pointed out in 1931 by Laubengayer. He stated that the beautiful iridescence exhibited by the glass is due to the selective destructive interference of light by the thin films on its surface.

According to Blodgett, when a glass is covered with a thin transparent film, the light reflected by the glass is governed by the laws of interference. A relationship must exist, therefore, between the thickness and color of films developed during chemical attack.

If there is a definite relationship between thickness and color of films, a new type of acid testing procedure might be developed. This suggests the measurement of the severity of attack in terms of film thickness by means of color.

Roberts (*Journal of the American Ceramic Society*, August 1949) presents the results of some work carried out along the foregoing line of thought and it is summarized here for its possible use in testing glass surfaces or applied colored enamels.

The visible spectrum, which consists of a mixture of components that vary in wave length from 4000 to 7000 a.u., can be divided arbitrarily into six broad bands or regions, namely, violet, blue, green, yellow, orange and red. One single component that will be representative of each band or region can then be selected for the purpose of discussion, as well as calculation.

If one of these spectral components, e.g., the green component with a wave length (λ) of 5350 a.u., falls on the surface of a thin film of thickness, t, and refractive index, n, it will follow two paths. One ray will be reflected at the film surface; the second ray will enter the film and be reflected at the glass-film boundary.

According to the laws of interference, the path difference, D, between the two rays will be equal to $2nt \cos r$, where r is the angle of refraction. The reflected light as seen by the eye will have maximum intensity when the path difference is equal to zero or even multiples of half wave length: $2nt \cos r = \frac{1}{2} \lambda m$; where $m = 0, 2, 4, 6$, etc. Conversely, when the path difference is equal to odd multiples of half wave length, the light will have minimum intensity. The intensity of the green component will thus vary with thickness of film, as shown in Fig. 1.

If all six of the components (in other words, white light) fall on the surface of a thin film having a thickness, t, and refractive index, n, the relationship between intensity and film thickness will be as shown in Fig. 2.

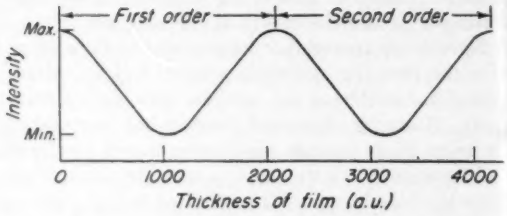


Fig. 1. Curve showing relationship between thickness of film ($n = 1.46$) and intensity of a ray of monocromatic light at 45° incidence.

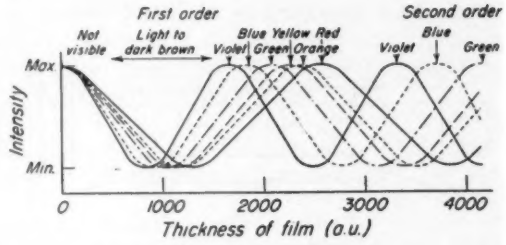


Fig. 2. Curve showing relationship between thickness of film ($n = 1.46$) and intensity of a beam of white light at 45° incidence.

Each of the six components shows a maximum as well as a minimum intensity. This variation in intensity is not uniform, however, since one component may exhibit a maximum intensity for a given thickness and another may exhibit a minimum intensity. If these differences in intensity are of the right order of magnitude, the reflected light as seen by the eye will be colored. For any given thickness of film, the component or combination of components that individually or collectively exhibits the highest intensity should be observed.

According to these curves, a film with a thickness of about 800 a.u. should be reddish brown since the violet and blue components are at their minimum intensity. The reddish brown should change with increase in film thickness (800 to 1500 a.u.) to dark brown, as the violet, blue, and green components increase in intensity at the expense of the orange, red and yellow components that decrease in intensity.

A violet-colored film of the first order should be about 1660 a.u. thick owing to the peak intensity of the violet component. As the film increases in thickness, the shift in colors should follow the shift in peak intensities of the other components. The violet should change progressively to blue, green, yellow, orange and red.

As already pointed out, the colors seen by the eye change progressively from one to another. Each color can therefore be divided into two shades: light and dark. If the reddish color that is seen in films having a thick-

(*Continued on page* 634)

CURRENT STATISTICAL POSITION OF GLASS

The new series of figures covering employment and payrolls in the glass manufacturing industry has become available this month and THE GLASS INDUSTRY resumes the issuance of these statistics. However, data for the period from January through April 1949 are not available and the new series of statistics starts with the month of May 1949.

Employment and payrolls: Employment in the glass manufacturing industry for the month of May 1949 was 105,900. This is only slightly more than the 105,400 persons employed during the month of June. Employment for July decreased about 3 per cent from June to reach 101,900 employed persons. During August employment rose about 5 per cent to reach 107,400 persons.

Payrolls for the month of May 1949 were about $26,070,000. During June, payrolls fell off close to 2 per cent to reach $25,567,000. July's payrolls continued on the downgrade and were $24,400,000, or 4½ per cent below June. During August, a total of about $26,136,000 was paid out by glass manufacturers, an increase of 7 per cent over the previous month.

Glass container production for the month of September 1949, based on figures released by the Bureau of Census, was 7,550,490 gross. This represents a drop of close to 13 per cent from August's 8,661,555 gross. During September 1948, production was 8,711,910 gross, which is about 13 per cent more than for September this year. At the close of the third quarter of 1949, glass container production has reached a total of 68,133,441 gross, as compared with 75,578,014 gross—a difference of close to 10 per cent.

Glass container shipments fell about 10½ per cent from the 9,127,134 gross shipped during August to reach 8,156,030 gross for September. Shipments during September 1948 were 10,442,430 gross. It will be recalled that shipments rose last year during this period due to a forthcoming increase in the price of glass containers. Total shipments of glass containers during the first three quarters of 1949 have reached 68,001,706 gross. This is 10 per cent below the 75,737,770 gross shipped during the corresponding period in 1948.

Stocks of glass containers on hand at the close of September 1949 were 8,318,335 gross, as compared with 8,905,699 gross on hand at the close of August and 7,246,472 gross on hand at the close of September 1948.

Automatic tumbler production for the month of August 1949 jumped close to 26 per cent to 4,907,180 dozens over July's 3,898,632 dozens. Production during August 1948 was 4,618,317 dozens. Shipments for August also rose sharply and were reported to be 5,156,646 dozens. This is close to 23 per cent above the 4,197,489 dozens shipped during July. Shipments during August 1948 were 4,676,099 dozens. Stocks on hand at the close of August were 7,714,855 dozens, as compared with 7,689,129 dozens on hand at the close of July and 7,396,999 dozens on hand at the close of August 1948.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for August 1949 were 3,322,951 dozens. This figure represents an increase of 31 per cent over the 2,528,315 dozens shipped during July. Sales during August 1948 were 3,052,145 dozens. At the close of the 12-month period ending August 1949, manufacturers' sales have reached a total of 39,556,457 dozens. This is almost 8 per cent below the sales of 42,930,586 dozens reported for the corresponding period in 1948.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	September 1949
Narrow Neck Containers	
Foods	1,164,091
Medicinal & Health Supplies	1,164,079
Chemicals, Household & Industrial	584,932
Beverages, Returnable	203,447
Beverages, Non-returnable	2,062
Beer, Returnable	102,930
Beer, Non-returnable	214,356
Liquors	784,406
Wines	336,989
Toiletries & Cosmetics	500,241
Sub-total (Narrow)	5,057,533
Wide Mouth Containers	
Foods	1,871,340
Dairy Products	340,567
Home Canning	204,801
Medicinal & Health Supplies	217,022
Chemicals, Household & Industrial	102,281
Toiletries & Cosmetics	93,983
Packers' Tumblers	93,238
Sub-total (Wide)	2,923,232
Total Domestic	7,980,765
Export Shipments	175,265
Total Shipments	8,156,030

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production September 1949	Stocks September 1949
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,963,459	2,917,266
	Wide Mouth	2,304,530	2,362,086
Dairy Products		334,097	228,227
Home Canning		*170,346	330,211
Beverages, Returnable		232,761	619,821
Beverages, Non-returnable		.....	11,957
Beer, Returnable		106,828	590,461
Beer, Non-returnable		196,585	301,988
Liquors		212,225	588,117
Wines		322,973	260,997
Packers' Tumblers		106,686	107,204
Total		7,550,490	8,318,335

* This figure represents Fruit Jars only.

INVENTIONS AND INVENTORS . . .

(*Continued from page* 621)

shown in Patent No. 2,338,868 to the same inventor. Reference should be made to the patent for the electrical connections and other details.

The following references are of record in the file of this patent: United States Patents: 1,640,567, Firestone, Aug. 30, 1927; 1,925,814, Nicolson, Sept. 5, 1933; 1,934,187, Glasgow et al., Nov. 7, 1933; 1,979,722, Zworykin, Nov. 6, 1934; 2,008,567, Simonton, July 16, 1935; 2,065,713, Knobel et al., Dec. 29, 1936; 2,219,572, Everett, Oct. 29, 1940; 2,313,218, Brace et al., Mar. 9, 1943; 2,318,856, Hoffman, May 11, 1943; and 2,335,686, Mercur, Nov. 30, 1943. Foreign Patents: 381,335, Great Britain, Oct. 6, 1932; and 649,180, Germany, Aug. 17, 1937.

CANADIAN GLASS MANUFACTURING 1948 REPORT

The Canadian Government reports that preliminary figures show that there was a total of 100 plants in operation in the glass manufacturing industry of Canada during 1948. An average number of 6,143 employees were paid $12,746,000 in salaries and wages, and the cost of materials at works amounted to $15,074,000. The gross selling value of products at works was $40,671,000.

This compares with 99 plants in the preceding year, average of 6,034 employees, salaries and wages of $10,917,000, cost of materials at works of $13,781,000 and gross selling value of products at works of $36,585,000.

WYANDOTTE ANNUAL CHEMICALS CONFERENCE

Keynoting creative selling as the theme, Bert Cremers, Vice President of Michigan Alkali Division of Wyandotte Chemicals Corporation, opened the firm's annual sales meeting of district managers and salesmen. Each section of the conference was preceded by a summary of conditions affecting the particular industry discussed. The general view of the speakers, continuing Mr. Cremer's opening remarks, was that there is nothing wrong with business that good, sound selling can't cure.

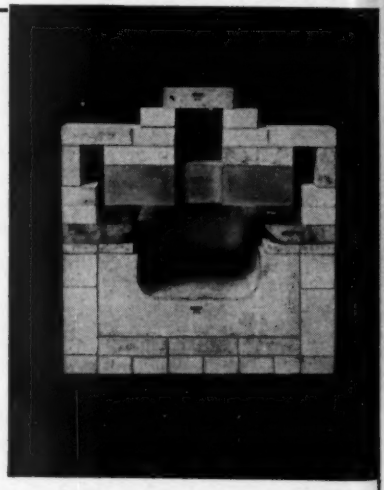
Discussion topics and leaders for the meetings were: Soda Ash, Caustic and Bicarbonate of Soda, Melvin E. Clark; Chlorine, Calcium Carbonate, Glycol and Organics, H. F. Roderick, L. S. Reid and V. H. Vodra; Calcium Chloride, L. D. Dodson and F. R. Sproule; Technical Service, C. S. Johnson and P. E. Burchfield; Distributors, P. M. Bigley; Research and Development, T. H. Vaughn; Advertising, Robert Raine; Traffic, W. S. Nevius.

A.S.T.M. SCHEDULES NATIONAL MEETINGS FOR 1950

The American Society for Testing Materials will hold national meetings in Pittsburgh and Atlantic City in 1950.

The A.S.T.M. Committee Week and Spring Meeting will be held at the Hotel William Penn, Pittsburgh, Pa., on February 27 through March 3. The Society's 53rd Annual Meeting will be held at Chalfonte-Haddon Hall, Atlantic City, N. J., on June 26 through June 30. In conjunction with the Annual Meeting will be held the Ninth Exhibit of Testing Apparatus and Related Equipment.

Cleaner Glass, Low Maintenance with **CRYSTALITE Forehearths**



REMMEY CRYSTALITE (mullite-bonded mullite) is produced in all shapes necessary to make up the forehearth assembly. Burner blocks, cover blocks, channels, spouts, tubes, plungers and orifice rings are built to meet specified requirements. These CRYSTALITE parts mean better, more efficient production by offering:

- ★ Accuracy in formation to eliminate time-wasting adjustments.
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Get Premium Performance Without Premium Price . . . by using REMMEY CRYSTALITE parts for your forehearth.

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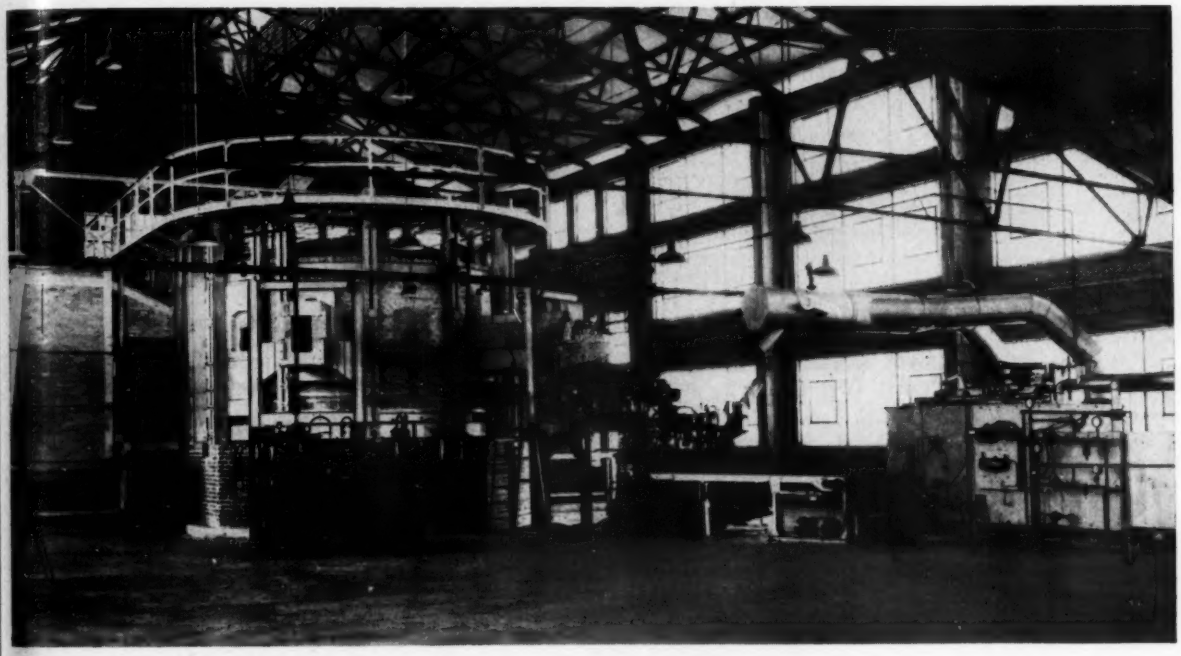
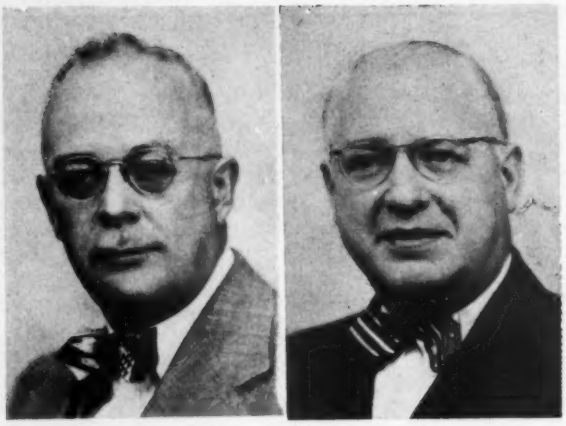


AMCO Installation During Construction Period . . .

AMSLER MORTON
CORPORATION
Chamber of Commerce Bldg., Pittsburgh 19, Pa., U.S.A.



R. L. WARREN G. A. MENGLE

BROCKWAY ELECTS BOARD CHAIRMAN AND NEW PRESIDENT

The Board of Directors of the Brockway Glass Company has elected R. L. Warren to the newly created office of Chairman of the Board. Glenn A. Mengle, Executive Vice President, has been named to Mr. Warren's former position of President.

Mr. Warren became President of the Brockway Machine Bottle Company in 1929 and Mr. Mengle was President of the Brockway Sales Company when the two organizations were consolidated.

The sales of Brockway Glass Company has steadily increased since 1928: from $875,000 in 1928 to $12,500,000. To produce this volume of high quality glass containers, the original plant of two tanks at Brockway, Pennsylvania, has been supplemented by two tanks at Crenshaw, Pennsylvania and one tank in Muskogee, Oklahoma.

E. H. SARGENT & CO. COMPLETES NEW CHICAGO PLANT

Completion of a new and modern building for the Chicago offices and plant of E. H. Sargent & Company has been announced by T. M. Mints, President.

The new plant houses complete engineering, production, merchandise handling and warehouse facilities, including engineering and drafting offices; complete instrument factory; physical and chemical laboratories; preparation laboratory; glass-blowing shop with grinding and graduating facilities; all-steel merchandise storage structures with fire-proof storage rooms for hazardous chemicals; inspection departments; and packing room equipped with the latest type belt conveyor system. Shipping facilities are a rail loading dock, rail spur and two inside motor truck docks.

ELECTION OF OFFICERS AT GLASS FIBERS

At a recent meeting of the Board of Directors of Glass Fibers, Inc., R. F. Mensing was elected Vice President and Treasurer and F. H. May, Jr., Vice President and Secretary and Assistant to the President. The announcement was made by R. H. Barnard, President of the firm.

Mr. May has been engaged in various executive capacities with the corporation since its early days. Mr. Mensing, who came to Glass Fibers in March 1948, had been director of the Federal and Property Tax Division of United States Gypsum Company at Chicago.

PAPERS TO BE PRESENTED AT THE ELEVENTH CONFERENCE ON GLASS PROBLEMS

The program for the Eleventh Conference on Glass Problems to be held December 8 and 9 has been announced. Papers to be presented are as follows:

Metals and Molds: Metal Problems in the Container Field, Neil Waterbury, Owens-Illinois Glass Co., Alton, Illinois; Metal Problems in the Semi-Automatic Glass Manufacturing Field, Kenneth McGrath, Altens Foundry and Machine Works, Inc., Lancaster, Ohio; Colloidal Graphite Treatment of Mold Surfaces, J. R. Murphy, Acheson Colloids Corp., Port Huron, Mich.; Some Aspects of Mold Manufacture and Use, Overmyer Mould Co., Winchester, Ind.

Heat Treating Problems: Basic Principles of Glass Annealing, Howard R. Lillie, Corning Glass Works, Corning, N. Y.; Basic Principles of Glass Tempering, Dr. Ralph K. Day, Libbey-Owens-Ford Glass Co., Toledo, Ohio; Practical Problems in the Heat Treating of Containers and Hollow Ware, F. E. Dorsey, Hartford Empire Co., Hartford, Conn.; Practical Problems in the Heat Treating of Flat Glass, Harold A. McMaster, Permaglas, Inc., Toledo, Ohio.

Quality Control: Basic Principles of Quality Control, Dr. J. H. Toulouse, Owens-Illinois Glass Co., Toledo, Ohio; Remarks on Quality Control in Glass Container Manufacture, Dr. K. C. Lyon, Armstrong Cork Co., Lancaster, Pa.; Opportunities for Quality Control in Flat Glass Manufacture, Fred Bishop, American Window Glass Co., Arnold, Pa.; A Practical Approach to the Evaluation of Amber Glass Melting Problems, W. H. Manring, Ball Bros. Co., Inc., Muncie, Ind.

MC KEE GLASS COMPANY CHANGES HANDS

The control of the 96-year-old, family-owned McKee Glass Company has changed hands, it has been announced by Arch K. Wood, President. Heirs of the founder, A. J. Smith, who have managed the company, now also control it through the purchase of the stock owned by other heirs.

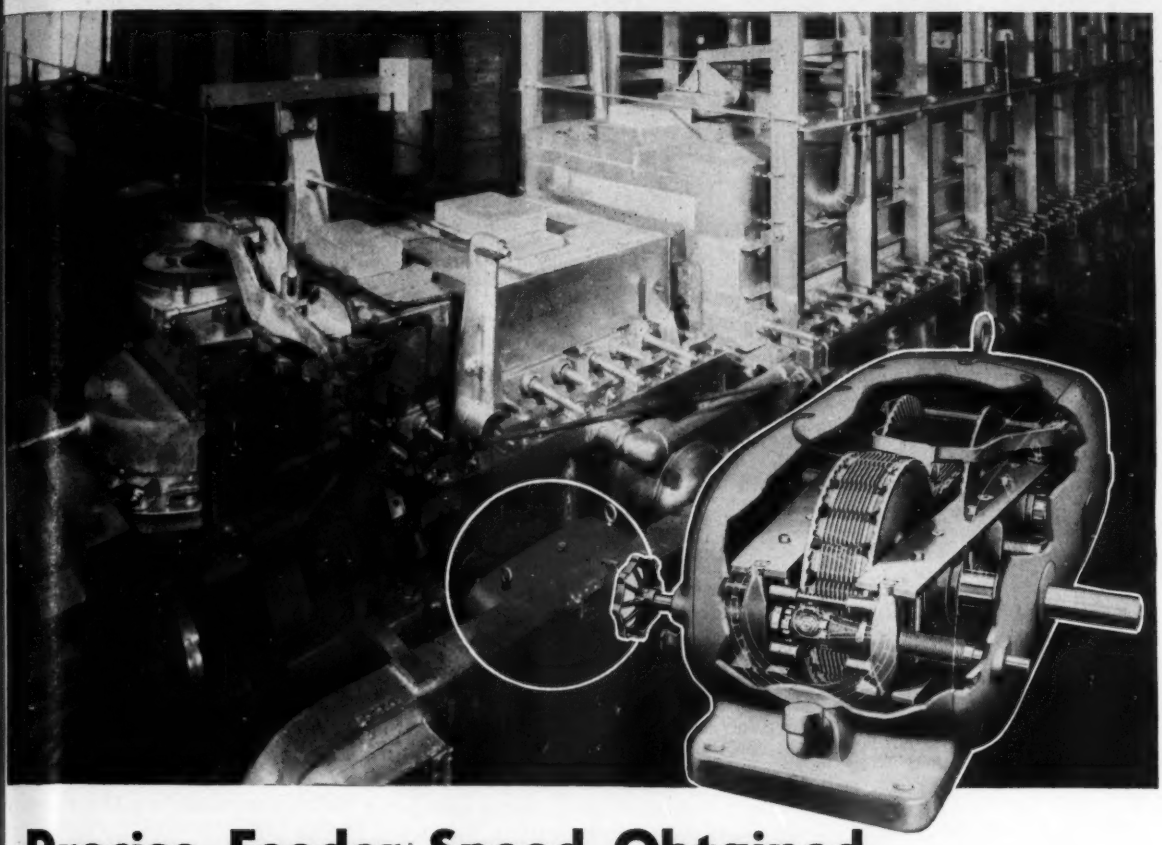
Following the reorganization, four new directors were elected. They are William G. Bechman, Howard T. Hardie, Dr. Frederick W. Lathrop and O. S. Wood. Members continuing on the board are Arch K. Wood, President; William A. Wood, Executive Vice President; and D. B. Pilkey, Treasurer. Other officers of the company are Robert L. Smith, Secretary; Dr. A. W. Wishart, Vice President and General Superintendent; and W. B. Smith, Assistant Treasurer.

CHAS. TAYLOR SONS CONSTRUCTING NEW TUNNEL KILN

The Chas. Taylor Sons Company has announced that a new tunnel kiln is now under construction at its Taylor, Kentucky, plant.

The building of the kiln, which is to be fired with natural gas with oil standby, is the latest in the series of modernization moves by the firm. Erection of the continuous kiln will increase production capacity and improve deliveries. The kiln is being built by the Allied Engineering Division of Ferro Enamel Corporation, and will be completed November 15.

UNIFORM GOBS Assure Uniform Ware



Precise Feeder Speed Obtained by LINK-BELT P.I.V. Variable Speed Drive

Timing of feed means much in terms of quality glassware. So Hartford-Empire Company uses the Link-Belt P.I.V. Variable Speed Drive as standard equipment on all variable-speed single feeders. Plunger and shear mechanisms on this machine are thus operated in exact synchronism with the forming machine. The unique chain and toothed and grooved wheel principle of the P.I.V. Variable Speed Drive gives positive power transmission, without possibility of slip or creep, and provides for infinite speed variation without steps, so that the most precise speed adjustment is easily obtained.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

11,608

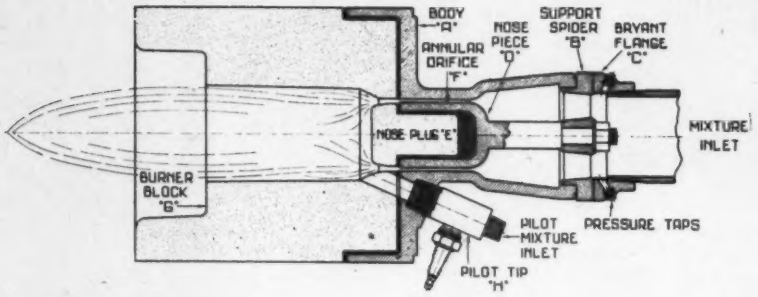
LINK-BELT

Power Transmission Machinery

"THE COMPLETE LINE"

Link-Belt P.I.V. Variable Speed Drives are supplied as standard equipment by various builders of glass working machinery. They are also easily adapted to existing drives. All-metal, wholly enclosed, rugged and efficient, they require negligible attention, can be arranged for remote control, and are available in several types, up to 25 h.p.

Send for Book 1874-B for complete information and application data.



BRYANT PYRONIC TUNNEL BURNERS

Bryant Industrial Division (Affiliated Gas Equipment, Inc.), 1020 London Road, Cleveland 10, Ohio, has announced the development of a new pyronic tunnel burner which will burn any combustible mixture of gas over a wide range of mixture pressures.

Available in capacities of from 6,000 to 1,600,000 BTU/Hr., the new burner is designed to operate efficiently without special adjustment anywhere in the 450-3100 BTU gas range, simplifying problems of furnace design, fuel changeover and standby operation.

Mixture pressures used may run from 0.1″ W.C. to 24 oz. or more, making possible low turn down and high pressure operation for high temperature operation. The burner's long annular port tends to eliminate backfire and turbulence at the port, making for easy lighting. The burners may be lighted from outside or inside the furnace, either manually or by spark plug blast pilot furnished for push-button ignition.

For operations up to approximately 2200F., high-grade super duty refractory blocks are supplied; for higher temperatures, sillimanite blocks are used.

ROL-AWAY HAND TRUCK

Honeyman Mfg. Company, 1217 N.W. Everett Street, Portland 9, Oregon, has announced a new one-man hand truck to be known as Model C.

The new model is a small four-wheel model designed for handling large size flat loads such as glass, sheet-metal, marble and other similar odd dimensional materials. It is fabricated of aluminum alloy pipe which fits into an angle steel base. The dimensions are 48″ high, 45″ long and 28″ wide.

Although the entire truck weighs only 50 pounds, it has a capacity of 600 pounds with 4-inch casters and 1200 pounds with 6-inch casters.

HEAT UNIT

Prat-Daniel Corporation, East Port Chester, Conn., has announced a new model of Thermoblock self-contained direct fired industrial heating units for drying lacquers, finishes or any material requiring temperatures up to 500°F.

Primary unit is a gas or oil fired heater of 300,000 or 550,000 BTU/Hr. employing forced air circulation. The new model is designed to re-circulate its air until the desired temperature is reached. The unit then discharges continuously at the temperature required.

COMBUSTION SAFEGUARD

The Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Illinois, has announced the 1300 Series Flame-otrol combustion safeguard for industrial and commercial fuel fired furnaces, ovens, boilers, kilns and other heating equipment.

The new Flame-otrol uses the flame itself as the "electronic link" in a simple, electronic circuit to provide instantaneous switching action. It is capable of detecting the presence or absence of a gas or oil flame of any type of burner eliminating the need for costly, specially designed equipment.

Features of the 1300 series are a guaranteed safe-start and interchangeable plug-in unit for increased program variety, for both manual or automatic ignition applications, easily adjustable to a wide selection of purge, preventilating and ignition program cycle combinations.

CATALOGUES RECEIVED

Dings Magnetic Separator Co., 4740 W. Electric Avenue, Milwaukee 14, Wisconsin, has issued an 8-page illustrated bulletin, "Dings Certified Magnetic Equipment."

The bulletin describes Dings electric and non-electric magnetic pulleys, non-electric magnetic drums, triple pole rectangular magnets, lifting magnets, etc. Data includes brief specifications, lists of applications and features of the equipment which is designed for separation of magnetic and non-magnetic products.

E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa., has issued a revised 6-page folder featuring its fast acting fuel oil additive which dissolves sludge in the oil storage tanks and the entire system. The solvent improves operating efficiency of the heating system and eliminates expensive cleaning jobs by making the sludge burnable with the oil.

In addition to describing the physical composition of Houghto-Solv, how it functions during operation of the system and the results obtained with this product, the folder features many photographs, including enlarged microphotos actually showing Houghto-Solv as it disperses sludge deposits.

Walsh Refractories Corporation, Department M, 101 Ferry Street, St. Louis, Mo., has issued a new bulletin featuring Mullitex, super duty fire brick, and Mullitex RB, special super duty refractory.

Properties, typical applications and detailed information on these and many other refractory materials are included in a convenient, reference table.

The company has also issued a four-page product bulletin, printed in both English and Spanish, featuring Walsh refractories for the glass industry. Included is a useful table listing representative refractory materials, their application, properties, fusion point, weight, amount required, packaging data and other helpful information for the refractories user. This bulletin may be obtained by writing to Department E.

Charles Englehard Inc., 850 Passaic Avenue, East Newark, New Jersey, has published a four-page bulletin which stresses the importance of efficient furnace combustion and describes the way the Englehard CO_2 Analyzer measures CO_2 content of flue gases to help keep air supply at an optimum level.

The bulletin explains that the efficient operation of the analyzer is due to the fact that it employs the proven thermal conductivity principle. No intricate outside circuits or mechanisms are needed. The bulletin points out that the Englehard CO_2 Analyzer works equally well whether coal, oil or gaseous fuels are used. The instrument not only indicates the proper air supply, but the temperature of the stack gases as well.

Hardinge Co., Inc., 240 Arch Street, York, Pa., has released a 32-page catalog covering its line of "Ruggles-Coles" rotary dryers, kilns and coolers.

In this new bulletin 16-D, it discusses direct, semi-direct and indirect heat dryers, double-shell and single-shell dryers, parallel-flow and counter-flow dryers, steam tube and hot air dryers. It covers air type, water spray, and partially submerged type rotary coolers, counter-flow rotary kilns for calcining, roasting or oxidizing.

Also included are overall dimensions of all models as well as typical flow sheets showing the various rotary units in continuous flow operations.

RESISTS ACID AND ALKALI

RESISTS SULFIDES

EASILY APPLIED FOR HIGH GLOSS

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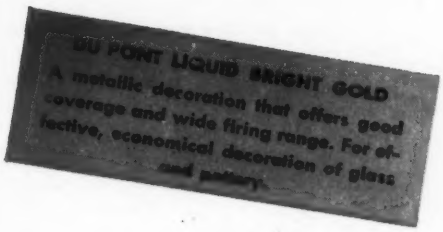
CONSULT US NOW for colors with properties to help you win more sales! Du Pont Glass Colors are made under scientific control to meet your every need—pre-tested for full color value before shipment. They can be matched to your exact needs. They're easily applied, easily adapted to the heaviest of multi-layer designs. Du Pont Glass Colors give smooth, even applications, fire to exceptionally high gloss. They're acid- and alkali-resistant—stand up under repeated exposure to caustic solutions, washing and sterilization. And these colors are unaffected by constant direct contact with foods containing sulfides.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A metallic decoration that offers good coverage and wide firing range. For effective, economical decoration of glass and pottery.

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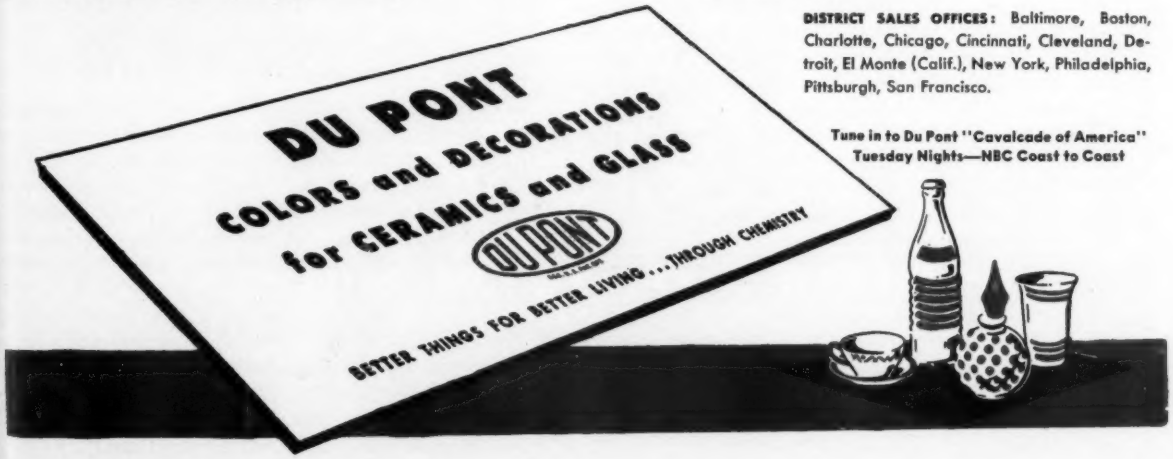
DISTRICT SALES OFFICES: Baltimore, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, El Monte (Calif.), New York, Philadelphia, Pittsburgh, San Francisco.

Tune in to Du Pont "Cavalcade of America" Tuesday Nights—NBC Coast to Coast



W. D. JONES T. C. WERBE

LYNCH CORPORATION MAKES APPOINTMENTS FOR MACHINERY SALES POSTS

Wendell D. Jones and Thomas C. Werbe, Jr., have been transferred to the Sales Department of the Glass Machinery Division of the Lynch Corporation, according to an announcement by newly elected President, M. H. Pendergast.

Mr. Jones has formerly been assisting on glass machine parts sales and service until R. H. Werbe recently assumed the position of Parts and Service Manager. Associated with Lynch Corporation for the past two years, Mr. Jones was formerly employed by a mid-western company. He has had experience in mold manufacture, pressed glassware production and automatic glass machinery repair and maintenance.

Mr. Werbe joins the Sales Department from his former position as Director of Manufacturing of the three Indiana Lynch plants. A Director and Vice President of the firm since 1945, he has also served with the Par Compressor and Package Machinery Divisions. He was Sales Manager of the Package Machinery Division until late 1948.

ENROLLMENT AT N. Y. STATE COLLEGE OF CERAMICS AT ALFRED

A total of 389 students, 54 of them women, enrolled in the New York State College of Ceramics at Alfred University for the first semester of the 1949-50 academic year. The college, which is celebrating its 50th anniversary this year, is offering a new course in "Engineering Indoctrination" to juniors in the Department of Ceramic Engineering.

The course deals with the ethics, practices and objectives of the engineering profession. It also will cover humanistic subjects that have a bearing on the professional and personal life of the engineer and industrial safety and hygiene practices.

Dean John F. McMahon of the N. Y. State College of Ceramics also announced the establishment of an undergraduate fellowship in ceramic dielectrics by the Electrical Reactance Corporation. The fellowship is one of four for undergraduate in the College. The fellowship will aid in the research and development of the use of titanates and other ceramic materials used in the electronic industry.

G. FRED RIEMAN TO HEAD BALL BROTHERS SALES; P. W. HATCH PROMOTED

The appointment of G. Fred Rieman as Director in charge of all Ball Brothers Company sales and the advancement of Philip W. Hatch to the Sales Managership of the Commercial Products Division have been announced by Edmund F. Ball, President.

The two appointments were occasioned by the sudden death of Fred J. Petty who, for nearly a quarter century, had served as Director of sales of packerware and commercial closures.

Mr. Rieman will be responsible directly to Mr. Edmund Ball for the formulation of policies, plans and programs for the sale of the company's products. He joined the Ball company in 1939 following his resignation as Vice President from Anchor Hocking Glass Corporation. Since then, Mr. Rieman has filled various manufacturing and sales assignments for the firm and at the time of his present appointment was head of the Fruit Jar and Domestic Products Division.

Mr. Hatch, who has been with Ball Brothers since 1932 except for time served with the U. S. Army, had been closely associated with Mr. Petty as Assistant General Sales Manager at the time of his present appointment, in planning and direction of sales of packerware and commercial closures. Mr. Hatch will now report to Mr. Rieman in connection with all commercial products sales.

LOUVER LIGHTING DEMONSTRATED BY CORNING

Different applications of a new form of louver lighting, developed by Corning Glass Works, were demonstrated at a special exhibit sponsored by the company at the Biltmore Hotel in New York City.

The new medium is manufactured as a thin pane of transparent glass. Throughout its length and depth are engrained, by means of a photographic process, white opalescent vanes in symmetrical, criss-cross pattern. The planes resemble embedded vanes of white paint but in reality are nothing but photographic images. When in use in a light fixture, according to Corning lighting engineers, this material allows direct illumination to pass through, at the same time blocking direct light angling to the side. The translucence of the louvers, however, creates a gentle diffusion of indirect light at side angles. Thus, glare is completely eliminated due to the 45 degree light cut-off possessed by the new medium, Foto-lite.

DUNBAR GLASS PRODUCES GLASS CYLINDERS IN QUANTITY

To meet industry demands, Dunbar Glass Corporation has become the first glass manufacturer to offer glass cylinders in a wide range of diameters and lengths and in any quantity from one cylinder to thousands, according to a recent statement by Henry E. Payne, President.

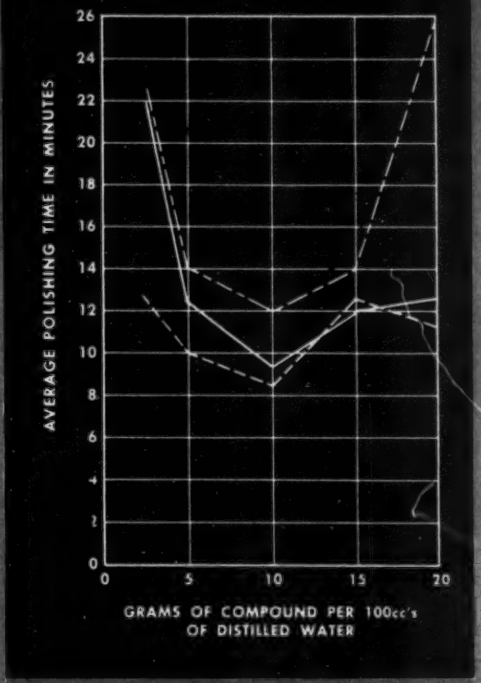
A 12-month survey of industry disclosed that most manufacturers have experienced difficulties in obtaining glass cylinders in economical quantities to meet their specifications, Mr. Payne reported. Thousands of glass cylinders designed to meet the needs and specific requirements of all industry are being turned out weekly in the plant facilities of Dunbar Glass Corporation. Mr. Payne further stated that a catalogue has been issued listing the wide range of cylinders available from Dunbar.

New Glass Polishing Compound

ZIRCONIUM OXIDE

for better, faster polishing at lower cost.

EFFECT OF SLURRY CONCENTRATION ON THE POLISHING SPEED USING SPECTACLE CROWN LENSES UNDER 8 PSI WITH PITCH FELT PAD ROTATING AT 168 RPM



TAM Zirconium Oxide is producing excellent results in a variety of commercial optical glass polishing applications. Its polishing action equals highest standards attained with substantial savings in material cost and polishing time. The use of ZrO_2 contributes greatly to cleanliness . . . an important factor in precision work. Working conditions are improved through elimination of discoloration common to the use of rouge.

Volume production experience in optical and glassware applications substantiates all claims made for efficiency, economy and other benefits. Complete details are available upon request to our New York office.

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PRINCIPLES OF AUTOMATIC CONTROL . . . .

(*Continued from page* 616)

Adjustments to suit the process consist of varying the intensities of the proportional and reset (proportional-speed-floating) actions. The adjustment for strength of the proportional component is the "proportional-band" or "throttling-range" adjustment as previously mentioned. It determines the change in temperature required to full-stroke the valve under the action of proportional control only. In most cases the construction of the controller is such that the means for changing the width of the proportional band also affects the floating speed, so that both actions are strengthened or weakened simultaneously, the actual floating speed being doubled when the proportional band is halved. The magnitude of the reset action can usually be changed independently of the proportional band. This permits calibration of a reset-setting dial in either "Reset Time in Minutes" or "Reset Rate in Repeats per Minute." Reset Time in minutes is the time required after a sudden and sustained displacement of the temperature index from the set point, for the effect of reset action to equal that of proportional action in moving the valve. If the sudden displacement of the index causes an immediate valve movement of ten percent of its range, then the reset time is the time required to move the valve another ten percent. Within reasonable limits the Reset Time is independent of the magnitude of the displacement used in determining it.

Reset Rate, expressed in repeats per minute, is the reciprocal of Reset Time. It is more commonly used than Reset Time in calibrating reset-setting dials.

The curves of Figure 8 show the nature of response to a sudden demand for the cases of: (a) not enough reset, (b) correct amount of reset, and (c) oscillations due to too much reset.

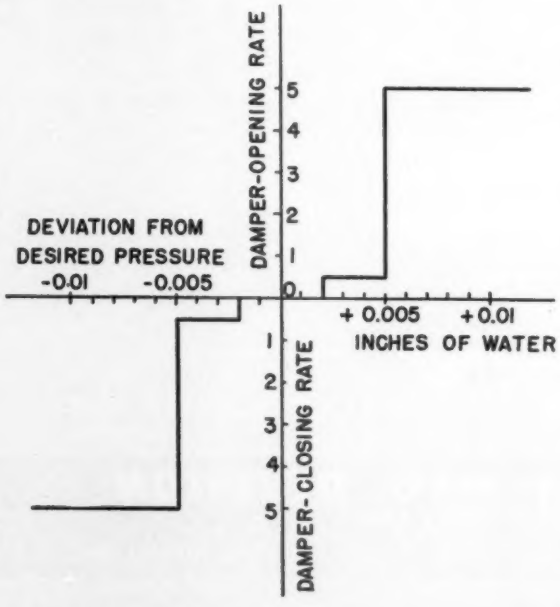

Fig. 10. Relation between rate at which damper opens and closes, and furnace pressure, in two-speed-floating control.

Proportional-plus-Reset-plus-Rate Control. In some applications, advantage can be gained by the addition of rate action to proportional or proportional-plus-reset action. The effect of rate action is to cause the control valve to be positioned by additional amounts as the rate at which temperature is rising or falling increases or decreases, the direction of valve movement always being such as to oppose change in the existing rate. Figure 9, is a graphical analysis of Proportional-plus-Reset-plus-Rate control. For purposes of illustration the temperature has been shown as suddenly starting to decrease at a maximum rate. Rate action calls for a corresponding sudden opening of the valve as seen in curve (e). Had the temperature started to fall half as fast as shown the sudden change in valve position would have been half as great as is indicated. As the rate of decrease of temperature becomes less, the effect of rate action decreases until when the temperature is momentarily steady at its minimum value it has no effect. Then, as the temperature returns towards the desired value similar changes take place in reverse order. The end result is to make additional heat energy available at the early stage of the disturbance and to hasten the re-establishment of a stable temperature.

A differential equation covering the action of a proportional-plus-reset-plus-rate controller may be written as follows:

$$-\frac{dy}{dt} = A\theta + B\frac{d\theta}{dt} + C\frac{d^2\theta}{dt^2}$$

y = valve position
θ = difference between actual temperature and the set point value
t = time
A = constant of reset-action term
B = constant of proportional-action term
C = constant of rate-action term

Expressed in words this equation states the the rate-of-change of valve position with time at any instant is given by the sum of three components: the first component (reset action) is proportional to the extent to which temperature deviates from the set point value; the second component (proportional action) is proportional to the rate-of-change of the deviation with time; and the third (rate action) is proportional to the rate-of-change of the rate-of-change of the deviation with time. The three constants A, B and C have values dependent upon adjustments made in fitting the controller to the process.

Average-Position Action

It is possible to obtain a large measure of the effect of any one of the more refined types of control action while using only two rates of heating, by means of what is known as "Average-Position-Action." The fundamental difference between this and two-position or on-off control, is that the shift from one heating rate to another is not based upon actions occurring when particular temperatures are reached, but is a matter of timing. By alternating between two instantaneous heating rates, with suitable timing, short-time-average heating rates corresponding to those required for various types of control action are obtained. If the frequency of alternation is made great enough, the effect of the short-time-average

(*Continued on page* 634)

There's a lot O' thinkin' in GLASS COLORS by PEMCO

Sure we have our problems—the same as you or anybody in business—but our business is solving and servicing *your* problems and producing the best Glass Colors available. And when we come up with the answer it is never the thinkin' of one man. There's a heap o' thinkin' in glass colors by Pemco. No single mind could develop the improvements for which the Glass Color Division at Pemco is responsible . . . improvements in stability . . . in resistance . . . in performance. These factors emphasize why this meeting of many minds is so important to *you*.

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PEMCO CORPORATION

Baltimore 24, Maryland

GLASS COLOR DIVISION

PRINCIPLES OF AUTOMATIC CONTROL . . .

(*Continued from page* 632)

rather than the instantaneous heating rate appears in the temperature record.

Single-Speed and Two-Speed Floating Control

Floating control action is rarely if ever used by itself for the control of temperature. It has been used to a considerable extent to control air pressure and air flow in connection with the operation of furnaces. Proportional-speed-floating action has already been described. Single-speed-floating and two-speed floating control have been widely used where rapid response of the process permits. Two-speed floating action is illustrated in Figure 10. When the air pressure is within the range of the dead zone, (+0.002 to —0.002) no control action takes place. For pressures outside of this range, the valve or damper is moved at a constant average rate until the pressure either returns within the region of the dead zone or reaches a deviation greater than ±0.005. For larger deviations the damper is moved at a new constant average rate much greater than the first. The direction of motion is, of course, such as required in each to return the pressure to within the dead zone. With single-speed floating control the damper moves continually at a single constant average speed as long as the pressure is outside of the dead zone.

THE GLASS DIVISION AT SHAWNEE INN . . .

(*Continued from page* 612)

greatest at the lower viscosities. Increase in viscosity due to this substitution is greater in the glasses containing 16% CaO·Mgo than in those containing 12%. b) In both series, substitutions of LiO_2 for Na_2O cause substantial reductions in viscosity throughout the given range.

5) In the case of resistance to attack by distilled water and by dilute acid, a) the substitution of K_2O for Na_2O causes an improvement in resistance to attack by distilled water in all cases. b) The resistance to attack by dilute acid is improved markedly by the substitution of K_2O for Na_2O in each of the three series. c) The substitution of LiO_2 for Na_2O results in a moderate decrease in resistance to attack by distilled water in both series. d) In the 10% dolomite series with 16% total alkali, the first 2% of Li_2O substituted for Na_2O has a negligible effect on the resistance to dilute acid, but further substitution results in an accelerated decrease. In the 12% dolomite series with 14% total alkali, the first 4% of Li_2O substituted for Na_2O has a negligible effect on the resistance to dilute acid, but further substitution causes a decrease in resistance.

RESEARCH DIGEST . . .

(*Continued from page* 622)

ness of 800 a.u. first becomes visible when the film thickness is 500 a.u., a relationship between film thickness and color may then be established.

In the enamel tests, two types of experiments were made. In the first, the effect of temperature on the resistance of one type of enamel to hydrochloric acid for various periods of time was determined and in the second, an attempt was made to determine the effect of the acid on different types of enamels at a constant temperature. After each exposure the specimens were washed and examined for color at 45° incidence. The color observed was recorded in terms of film thickness. According to these preliminary tests, the color changes that are brought about by chemical attack agree with those which should occur theoretically.

CERAMIC ASSOCIATIONS PAY TRIBUTE TO 50TH ANNIVERSARY OF N. Y. STATE COLLEGE OF CERAMICS

At the 16th Annual Meeting of the Ceramic Association of New York, tribute was paid to the 50th Anniversary of the New York State College of Ceramics of Alfred University with an extended program including representation of the Upstate New York Section of the American Ceramic Society.

The program included papers from the Research Department of the College and covered the all-inclusive subjects of glass and ceramics products. A brochure was presented containing synopses of issued reports and progress reports of work now underway. Articles of interest designated as "Glass" which are contained in the brochure are "Effect of Minor Additions on Surface Tension of Glass", "Extinction Coefficient of Copper in Copper-Blue Glasses", "Immiscibility in the Lime-Boric Oxide System" and "The Role of Titania in Silica Glass". The brochure also includes articles on New York State Mineral Resources Survey, Refractories, Heavy Clay Products, Enamels, Whiteware, Material and Equipment and articles of a general nature.

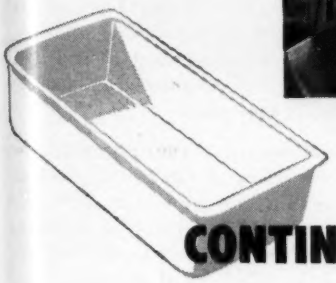
PH.D. DEGREES AWARDED AT UNIVERSITY OF ILLINOIS

Doctor of Philosophy degrees have been received by James A. Crookston and Jay E. Comeforo from the University of Illinois, Department of Ceramic Engineering. Both men did their graduate theses work on refactories.

Dr. Crookston held the A. P. Green Company Fellowship at Illinois and his work was titled "The Effects of Exchangeable Bases on the Fired Properties of Fire Clays". He received his B.S. degree in 1942 and his M.S. degree in 1946 from the Missouri School of Mines and Metallurgy. He recently accepted research work in the Hays Laboratory, Harbison-Walker Refractories Company.

Dr. Comeforo, whose thesis work was on "The Wetting of Alumina-Silica Refractories by Molton Glass and Its Significance", received his B.S. degree in 1944 and his M.S. degree in 1946 from Rutgers University. While doing graduate work at Rutgers, he held positions of Research Assistant and Associate, teaching several undergraduate subjects. At the University of Illinois, Dr. Comeforo held the position of Research Associate in the Department of Ceramic Engineering, working on the Army Air Force cooperative research project. During his last year of study, he held the Illinois Clay Products Company Fellowship. He recently accepted a position with the Bureau of Mines, Electrotechnical Laboratory.

Porcelain-enameled ware leaving Gas-fired continuous oven in which porcelain is fused on steel.



CONTINUOUS GAS FURNACES

Expedite Porcelain-Enamelling Operations

Continuous GAS furnaces, installed in the production lines, expedite finishing operations at Strong Manufacturing Company, Sebring, Ohio. In this finishing cycle, porcelain enamel is fused on steel as the press-formed units pass through high-temperature chambers.

This application of GAS is another typical example of the use of modern Gas Equipment right in the production line, to take full advantage of time-saving and labor-saving characteristics of this ideal industrial fuel. The results are typical, too—

- Uniform heat reduced number of rejects.
- Furnace life increased 100% over furnace using previous fuel.
- Reduction in fuel cost per enamelled unit.
- Increased lustre in porcelain due to plant cleanliness.
- Automatic heat control permits productive use of furnace overload capacity.

In every industrial process requiring heat there's a place for GAS and modern Gas Equipment. And in most of these processes the Gas Equipment can be placed right in the production line to take full advantage of the flexibility and economy of GAS. Your local Gas Company Representative will show you how it's done.

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420 LEXINGTON AVENUE, NEW YORK, N.Y.

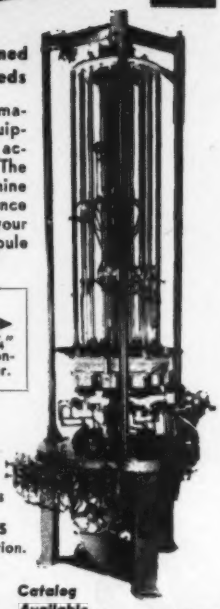
Kahle

AMPULE BLOWING MACHINERY

is specifically designed to meet your particular needs

Kahle machinery is not stock machinery! Every piece of Kahle equipment is specifically designed to accomplish a specific purpose. The Automatic Ampule Blowing Machine shown here illustrates the experience and ingenuity we can place at your disposal to help solve your ampule and bulb blowing problems.

AUTOMATIC AMPULE BLOWING MACHINE →
Will blow up to 2½" o.d. by 7¼" overall length, including stem or constricted neck. Speeds up to 2400 per hr.



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- Incandescent Lamps
- Neon Tubes
- Photo Cells
- X-Ray Tubes
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OFFICIAL STANDARDS FOR CONTAINERS FOR INJECTION . . .

(*Continued from page* 605)

Type I. Glass containers which when subjected to the test for *powdered glass* shall yield a titration equivalent to not more than 1.0 cc. of 0.02 *N* sulfuric acid per 10 Gm. of glass. The containers may be sterilized either before or after filling. Such containers are of highly resistant glass, usually borosilicate.

Type II. Glass containers which when subjected to the test for *water attack at 121°* shall yield alkali equivalent to not more than 0.7 cc. of 0.02 *N* sulfuric acid per 100 cc. of attacking medium or when subjected to the test for *acid attack at 121°* shall consume acid equivalent to not more than 0.7 cc. of 0.02 *N* sulfuric acid per 100 cc. of attacking medium. The containers must be sterilized before filling. Such containers are usually of treated soda-lime glass.

Type III. Glass containers which when subjected to the test for *water attack at 121°* shall yield alkali equivalent to not more than 5.0 cc. of 0.02 *N* sulfuric acid per 100 cc. of attacking medium or when subjected to the test for *acid attack at 121°* shall consume acid equivalent to not more than 2.0 cc. of 0.02 *N* sulfuric acid per 100 cc. of attacking medium. Containers must be sterilized by dry heat before filling. Such containers are usually of soda-lime glass.

Type IV. Glass containers which when subjected to the test for *water attack at 121°* or *acid attack at 121°* shall yield a titration equivalent to not more than 0.20 cc. of 0.02 *N* sulfuric acid per 100 cc. of attacking medium. Containers may be sterilized before or after filling. Such containers are usually of treated soda-lime glass.

Note: In Types II, III, and IV the choice between a test for water attack or acid attack is determined by the nature of the intended contents. If the *p*H of the intended contents is below 5.0, acid is to be used as the attacking medium. If the *p*H is 5.0 or above, the special distilled water is to be used as the medium.

The relative resistance of the various types is approximately in the following order: Type I, Type IV, Type II, and Type III, with Type I being generally the most resistant and Type III usually the least. This order of resistance does not apply under all conditions since it is at times difficult to compare containers tested by different procedures. For example, Type I containers near the limit of 1.0 cc. of 0.02 *N* sulfuric acid per 10 Gm. of powdered glass may not be more resistant than Type IV containers which are tested by subjecting the whole container to the attacking medium, even though generally speaking Type I containers are more resistant than Type IV containers. When a particular type of container is suggested for a specific injection, containers of a more resistant type may be used.

FORTIFIED WITH

ALCOA ALUMINA

THIS REFRACTORY BRICK HAS A WIDER RANGE OF USEFULNESS

Refractories made from fire clay, diaspore, kyanite and sillimanite are improved by fortifying their natural alumina content with ALCOA Alumina. Their maximum operating temperatures are raised . . . high-temperature, load-bearing strengths are increased . . . and resistance to chemical attack is greater. *These improvements give the refractories a wider range of usefulness!*

Performance characteristics improve in almost direct ratio to the alumina content of each refractory.

Fortifying refractories with ALCOA Alumina is easy. But to obtain the maximum service qualities, the grade of ALCOA Alumina most suited to the job should be used.

We do not make refractories, but we shall be glad to discuss with you the characteristics and properties of the various grades of ALCOA Alumina, and recommend the one best suited to *your* purpose. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1467L, Gulf Building, Pittsburgh 19, Pa.

Alcoa Chemicals

ALUMINAS and FLUORIDES

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ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

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Automatic Glass Machinery
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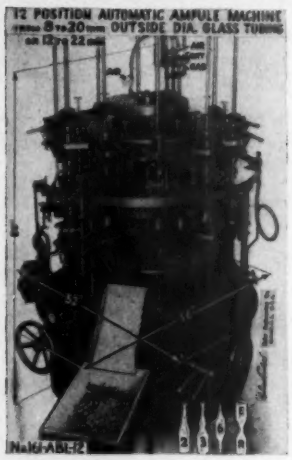

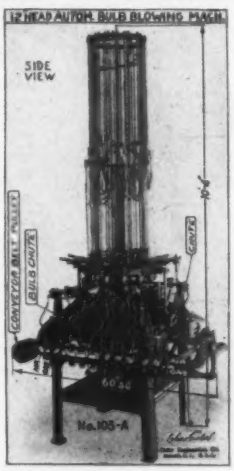

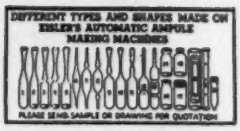

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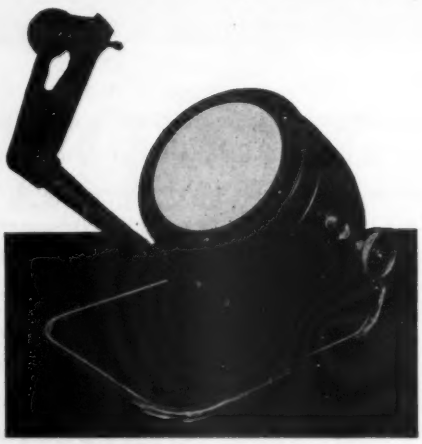

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PROPOSED DURABILITY TESTS FOR GLASS AND GLASS CONTAINERS . . .

(*Continued from page* 603)

tests were sponsored by the USP Glass Containers Advisory Committee, (G. D. Beal, Chairman) and Subcommittee VIIA on Pharmaceutical Containers (F. C. Flint, Chairman) of Committee C-14, ASTM. The following members of these committees lent their active and extended cooperation in the discussions and experimental work necessary to the development of the tests: O. G. Burch and F. R. Bacon, Owens-Illinois Glass Company; F. C. Flint and R. F. Ferguson, Hazel-Atlas Glass Company; C. H. Hahner and F. W. Glaze, National Bureau of Standards; K. L. Waters, Mellon Institute (now University of Georgia, School of Pharmacy); D. L. Deardorff, Mellon Institute; K. C. Lyon, Armstrong Cork Company; F. R. Matson, Armstrong Cork Co. (now Pennsylvania State College); J. P. Majeske and J. Hoffner, T. C. Wheaton Company; M. W. Green, American Pharmaceutical Association Laboratory; A. L. Hinson, Kimble Division, Owens-Illinois Glass Company; and Lt. A. L. Maines, Army-Navy Procurement Office, New York.

Grateful acknowledgment is made to Justin L. Powers, Editor of the *Bulletin of the National Formulary Committee* for permission to use material which has been published in that bulletin.

REFERENCES

1. R. F. Ferguson, Hazel-Atlas Glass Company.
2. A. L. Hinson, Kimble Glass Division, Owens-Illinois Glass Company.

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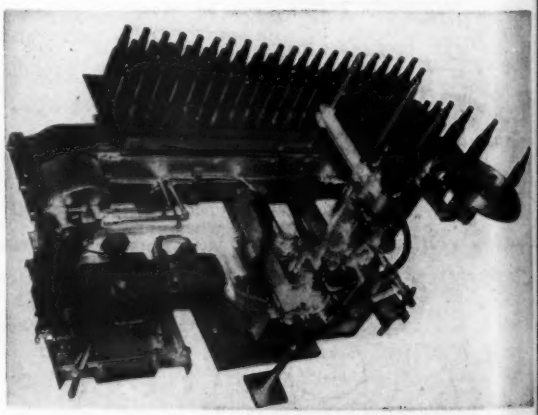

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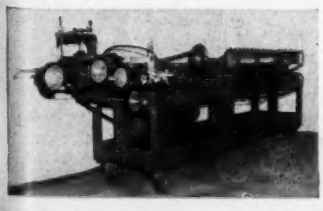

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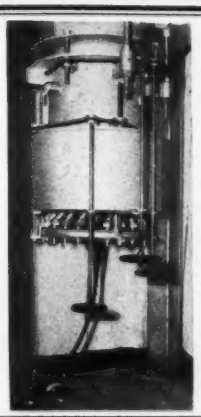

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FOOTE MINERAL ADDS TO STAFF

Dr. S. C. Ogburn, Jr., Manager Research and Development and Director of Foote Mineral Company, has announced the addition of five new men to his organization.

Harry B. Hunter, joining the staff as a metallurgist, received his master's degree at the University of Pennsylvania where he also served as assistant instructor in metallurgy. J. M. Kishel joins Foote Mineral's Research and Development laboratories as a chemist in the analytical section following employment by American Viscose Corporation as control chemist.

Edward Loveland joins the staff as ceramic research assistant; Dr. Everett R. Johnson as research chemist; and David Coghlan as a chemical engineer to conduct pilot plant studies. Mr. Loveland received his B.S. in Ceramic Engineering from Rutgers University; Dr. Johnson has a B.A. University of Iowa, M.A. Harvard University and Ph.D. University of Rochester; and Mr. Coghlan received his B.E. from Yale in 1941.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

THE GLASS INDUSTRY, published monthly at 55 West 42nd Street, New York 18, N. Y., for October 1, 1949, State of New York, County of New York, ss:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John T. Ogden, who, having been duly sworn, according to law, deposes and says that he is the Publisher of THE GLASS INDUSTRY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: John T. Ogden, publisher, 55 West 42nd Street, New York 18, N. Y. Cyril B. Delgado, editor, 55 West 42nd Street, New York 18, N. Y. Managing editor, none. Cyril B. Delgado, business manager, 55 West 42nd Street, New York 18, N. Y.

2. That the owners are: Ogden Publishing Company, 55 West 42nd Street, New York 18, N. Y. John T. Ogden, 55 West 42nd Street, New York 18, N. Y. Katherine Waller Ogden, 55 West 42nd Street, New York 18, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortgages, or other securites are: None.

4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has not reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed)
JOHN T. OGDEN, *Publisher.*

Sworn to and subscribed before me this 22nd day of September, 1949.

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